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# ***SILVER BOW CREEK INVESTIGATION***

FIELD OPERATIONS PLAN  
FOR THE  
WARM SPRINGS TREATMENT PONDS INVESTIGATIONS

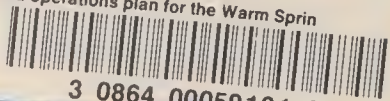
SILVER BOW CREEK RI/FS  
EPA REGION VIII



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FIELD OPERATIONS PLAN  
FOR THE  
WARM SPRINGS TREATMENT PONDS INVESTIGATIONS

SILVER BOW CREEK RI/FS  
EPA REGION VIII

Prepared By:  
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August 3, 1987

MAY 15 1991

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FIELD OPERATIONS PLAN -- LIST FOR DISTRIBUTION

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## LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980
CFR	Clark Fork River
CLP	EPA's Contract Laboratory Program
DBMS	Data Base Management System
EMSL	Environmental Monitoring Systems Laboratory
EPA	United States Environmental Protection Agency
ESD	EPA's Environmental Services Division
FIT	Field Investigation Team
FOP	Field Operations Plan
FS	Feasibility Study
DVARP	Data Validation and Reduction Protocol
ITR	Inorganic Traffic Report
LAP	Laboratory Analytical Protocol
MDHES	Montana Department of Health and Environmental Services
NBS	National Bureau of Standards
NCP	National Oil and Hazardous Substances Contingency Plan (40 CFR, Part 300)
NEIC	National Enforcement Investigations Center
NETSOP	Northern Engineering's Standard Operating Procedure
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
O&M	Operation and Maintenance
PE	Performance Evaluation
PRP	Potential Responsible Party
QAM	Quality Assurance Manager
QAO	Quality Assurance Office



QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
REM	Remedial Planning Team
RI	Remedial Investigation
ROES	Remedial Oversight Enforcement Support
RPTL	CH2M HILL's Remedial Planning Team Leader
RSP0	EPA's Remedial Site Project Officer
SAS	Special Analytical Service
SCS	Department of Agriculture, Soil Conservation Service
SMO	EPA's Sample Management Office
SMPM	State of Montana Project Manager
SOP	Standard Operating Procedure
SPM	CH2M HILL's Site Project Manager
SRM	Standard Reference Material
SSPM	Subcontractor Site Project Manager
SQAM	Subcontractor Quality Assurance Manager
USDA	United States Department of Agriculture
USGS	United States Geological Survey



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## 1.0 INTRODUCTION

### 1.1 PURPOSE AND SCOPE OF WORK

This Field Operations Plan (FCP) provides guidance for data collection efforts associated with the Warm Springs Treatment Ponds (Figure 1-1). These data collection efforts include surface water sampling, ground water sampling, sampling of sediments and pore water, and treatability tests of pond inflow. These data are necessary to evaluate potential remedial actions at the Warm Springs Ponds during subsequent feasibility studies. Further rationale and justification for performing work tasks are contained in the Draft Silver Bow Creek Selected Data Gaps Study Plan (CH2M HILL, 1987a).

### 1.2 SITE DESCRIPTION

The Warm Springs Treatment Ponds were constructed by the Anaconda Minerals Company to trap mining-related wastes from Silver Bow Creek and the Opportunity Ponds and prevent them from entering the Clark Fork River. These wastes originated in two locations: the Butte area, where the majority of mining activity in the area has taken place over the last 100 years, and in Anaconda, where major smelting operations were performed on ore from Butte. A more detailed account of the site's history and recent operations is contained in MultiTech (1987).

Figure 1-2 is a schematic of the Warm Springs Treatment Ponds area. Silver Bow Creek enters Pond 3 from the south, although high flows are typically routed untreated around the ponds by way of the Mill-Willow Bypass. Pond 3 is routed into Pond 2 and the Wildlife Ponds. Discharges from Pond 2 and the Wildlife Ponds are directed into the Mill-Willow Bypass (Figure 1-2). The Clark Fork River is formed at the confluence of the Mill-Willow Bypass and Warm Springs Creek. Pond 1 is no longer in active use; however, it contains considerable quantities of metal-enriched sediment and precipitates.



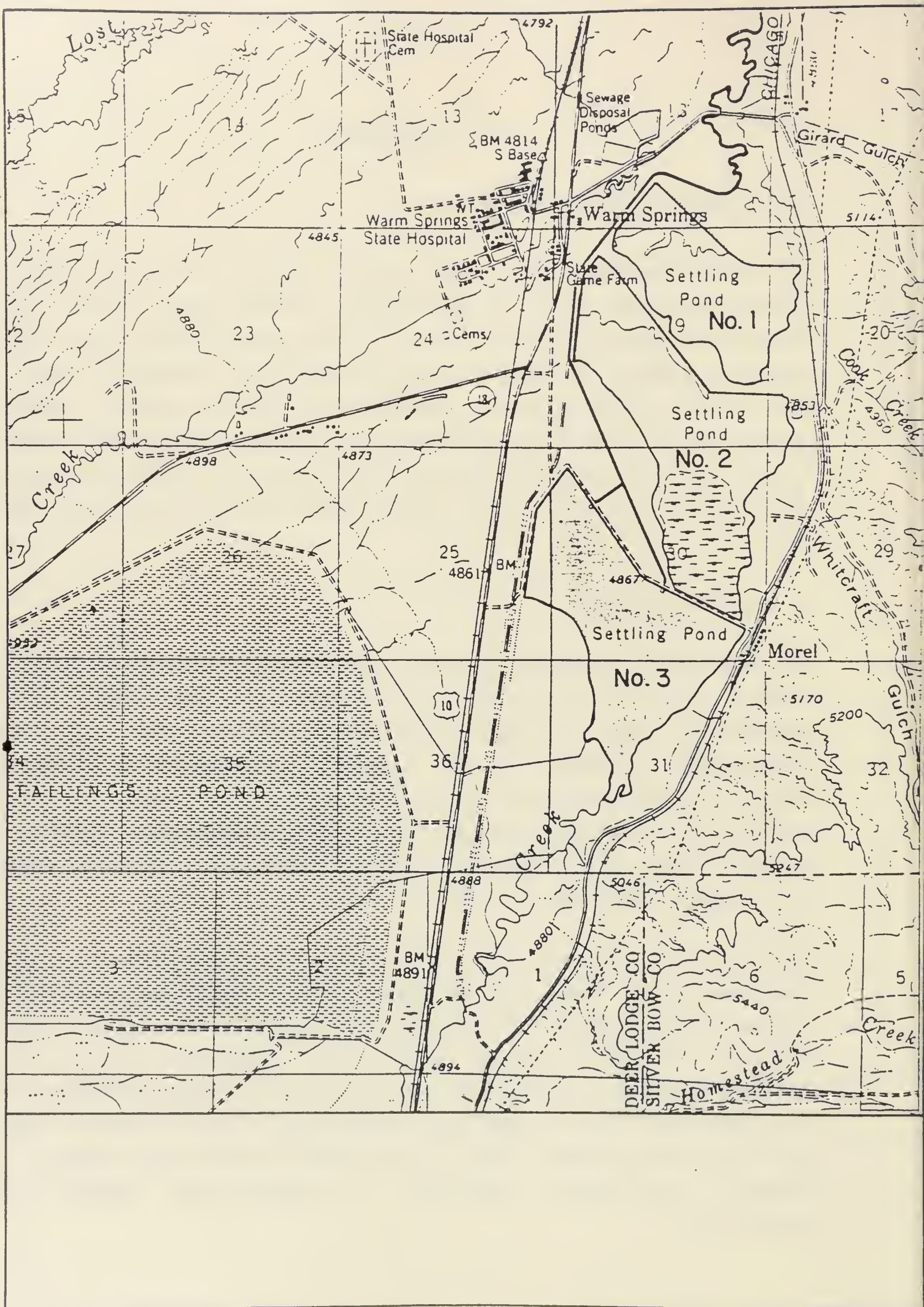


FIGURE 1-1. Warm Springs Treatment Ponds, Montana.

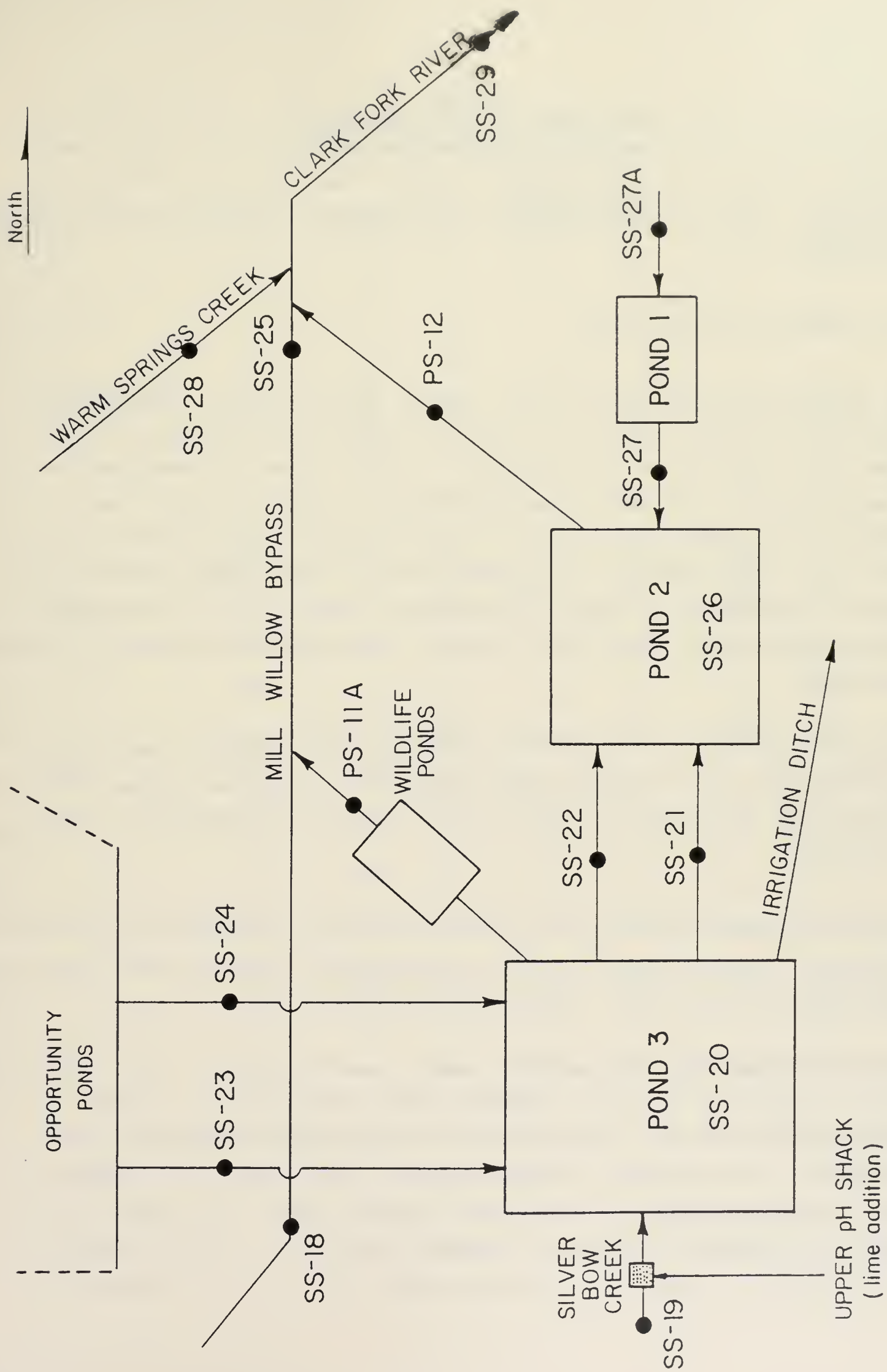


FIGURE 1-2. Warm Springs Treatment Ponds Area Schematic and Initial RI Sampling Sites.



Two mechanisms were historically used to reduce metal concentrations in discharges from the Warm Springs Treatment Ponds: reducing inflow stream velocity in the ponds and allowing suspended sediments to fall out of suspension; and, increasing the pH of the ponds to precipitate metals out of solution.

### 1.3 PREVIOUS INVESTIGATIONS

The objectives of the initial Warm Springs Ponds Remedial Investigation (RI) (MultiTech, 1987) were to evaluate the extent and severity of surface water and ground water contamination in the area, to evaluate the effectiveness of the water treatment system in metals removal, and to develop other information useful in evaluating future remedial options for this site. Data collected from December 1984 to August 1985 provided the basis for evaluating the removal efficiencies of metals and for identifying the principal metals removal and release mechanisms occurring within the pond system.

Figure 1-2 exhibits the surface water sampling sites that were used during the 1984-1986 initial RI period (MultiTech, 1987). Selected surface water quality data for these RI sites and this RI period are summarized on Tables 1-1 and 1-2.

Figure 1-3 locates the ground water monitoring wells constructed during the initial RI study period, and Table 1-3 summarizes selected ground water quality data from the same investigation (MultiTech, 1987).

Federal drinking water standards for arsenic, cadmium, copper, iron, lead, and zinc generally were not exceeded during the initial RI, neither in discharges from the Warm Springs Ponds to the upper Clark Fork, nor within the ponds. The four-day (chronic) aquatic life criteria for cadmium, copper, lead, and zinc, and the one-hour (acute) aquatic life criteria for zinc were exceeded occasionally throughout the ponds. The acute aquatic life criteria for copper was usually exceeded within the pond system, but

TABLE 1-1  
WARM SPRINGS PONDS WATER QUALITY DATA  
AVERAGE VALUES OF SELECTED PARAMETERS

PARAMETER <sup>a</sup>	SS-19	SS-20	SS-21	SAMPLE STATION <sup>b</sup>		SS-24	SS-28	SS-29
				SS-22	SS-23			
Flow (cfs)	73	NA	24.2	28.3	1.3	0.97	61.5	152
Temperature (°C)	14.5	8.2	11	11	8.8	9.7	5.9	6.9
pH (s.u.)	8.4	8.3	8.3	8.4	6.9	7.4	7.8	7.8
SC (umhos/cm @25°C)	343	451	446	450	2203	2461	568	472
TSS	15	8	6	5	15	6	9.3	7.4
SO <sub>4</sub>	66	119	110	114	1260	1401	182	133
Nitrate	3.13	2.31	2.74	2.23	1.97	2.10	1.9	2.1
Alkalinity	92	94	92	92	112	218	125	108
Hardness	148	170	173	173	1322	1515	261	200
As (T)	0.019	0.012	0.013	0.012	0.010	0.004	0.007	0.013
Cd (T)	0.0012	0.0009	0.0008	0.0007	(c)	0.0001	0.001	0.001
Cu (T)	0.170	0.083	0.074	0.064	0.027	0.031	0.040	0.059
Cu (D)	0.041	0.007	0.007	0.006	0.004	0.001	0.029	0.029
Pb (T)	0.012	0.006	0.005	0.004	0.011	0.016	0.004	0.008
Fe (T)	0.979	0.670	0.681	0.535	6.92	0.579	0.306	0.445
Fe (D)	0.048	0.013	0.033	0.030	5.02	0.377	0.032	0.036
Zn (T)	0.415	0.268	0.266	0.288	0.288	0.198	0.015	0.090
Zn (D)	0.163	0.148	0.124	0.120	0.280	0.054	0.014	0.051

\* 1984-1986 Period of Record

TABLE 1-2  
WARM SPRINGS PONDS WATER QUALITY DATA  
MAXIMUM AND MINIMUM VALUES OF SELECTED PARAMETERS

PARAMETER <sup>a</sup>	SAMPLE STATION <sup>b</sup>									
	SS-19		SS-20		SS-21		SS-22		SS-23	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Flow (cfs)	112	28	NA	NA	61.8	5.2	74.8	4.5	2.3	0.15
Temperature (°C)	24	6	22	0.0	26	1.5	22	4	19	0.5
pH (s.u.)	9.5	7.1	9.6	6.8	9.4	7.3	9.3	7.2	7.8	6.5
SC (umhos/cm @ 25°C)	702	287	588	287	696	358	616	360	3050	1870
TSS	40	8	29	(c)	36	(c)	18	(c)	31	(c)
SO <sub>4</sub>	81	49	190	54	140	98	177	91	1490	1000
Nitrate	5.2	1.2	4.8	(c)	9.8	(c)	6.3	(c)	6.0	0.67
Alkalinity	106	81	125	60	127	64	143	62	130	91
Hardness	235	107	254	79	236	75	248	62	1510	1140
AS (T)	0.048	0.0014	0.023	(c)	0.026	0.0014	0.025	(c)	0.025	(c)
Cd (T)	0.0021	0.0004	0.0027	(c)	0.0029	0.0004	0.0018	(c)	0.0003	(c)
Cu (T)	0.262	0.094	0.202	0.014	0.218	(c)	0.183	0.017	0.065	(c)
Cu (D)	0.059	(c)	0.076	(c)	0.045	(c)	0.033	(c)	0.054	(c)
Pb (T)	0.028	0.0018	0.015	(c)	0.018	(c)	0.020	(c)	0.129	(c)
Fe (T)	2.28	0.435	2.06	0.129	2.14	0.172	1.84	0.104	24.2	0.246
Fe (D)	0.107	0.016	0.047	(c)	0.283	(c)	0.324	(c)	21.4	(c)
Zn (T)	0.642	0.240	0.620	0.036	0.811	0.049	0.524	0.027	0.632	0.063
Zn (D)	0.321	0.038	0.502	(c)	0.421	(c)	0.415	(c)	0.642	0.054

(a) Values in mg/L unless otherwise noted: (T) is total; (D) is dissolved.

(b) Sample station locations shown on Figure 1-2.

(c) Minimum below detection.

\* 1984-1986 Period of Record



TABLE 1-2  
WARM SPRINGS PONDS WATER QUALITY DATA  
MAXIMUM AND MINIMUM VALUES OF SELECTED PARAMETERS  
(continued)

PARAMETER <sup>a</sup>	SAMPLE STATION <sup>b</sup>									
	SS-24		SS-18		SS-25		SS-26		SS-27A	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Flow (cfs)	1.8	0.36	87.3	3.3	91	12.9	NA	NA	2.2	0.40
Temperature (°C)	23.5	0.0	13	0.5	24.0	1.0	23.0	0.0	25	1.0
pH (s.u.)	7.8	6.8	8.0	6.9	8.5	7.1	10.1	6.8	8.1	6.5
SC (umhos/cm @ 25°C)	2800	2290	398	102	785	203	596	416	1740	1130
TSS	17	(c)	10	(c)	9	(c)	45	(c)	19	2
SO <sub>4</sub>	1580	1160	80	13	260	46	192	114	998	425
Nitrate	5.0	(c)	2.80	(c)	3.70	(c)	4.30	(c)	4.20	0.48
Alkalinity	268	158	125	33	129	45	137	43	192	95
Hardness	1870	614	218	51	344	88	268	72	988	499
AS (T)	0.019	(c)	0.105	(c)	0.120	(c)	0.034	(c)	0.012	(c)
Cd (T)	0.0006	(c)	0.0012	(c)	0.0012	(c)	0.012	(c)	(c)	(c)
Cu (T)	0.100	(c)	0.092	(c)	0.100	(c)	0.419	0.010	0.055	(c)
Cu (D)	0.021	(c)	0.031	(c)	0.022	(c)	0.019	(c)	(c)	(c)
Pb (T)	0.192	(c)	0.0076	(c)	0.0076	(c)	0.033	(c)	0.0086	(c)
Fe (T)	1.46	0.229	0.470	0.170	0.690	213	5.80	0.067	7.99	0.047
Fe (D)	3.00	(c)	0.446	(c)	0.190	(c)	0.139	(c)	5.34	(c)
Zn (T)	1.68	0.035	0.377	0.010	0.304	0.026	1.41	0.010	0.135	0.016
Zn (D)	0.146	0.019	0.345	(c)	0.244	(c)	0.374	(c)	0.127	(c)

(a) Values in mg/L unless otherwise noted: (T) is total; (D) is dissolved.

(b) Sample station locations shown on Figure 1-2.

(c) Minimum below detection.

\* 1984-1986 Period of Record

TABLE 1-2  
WARM SPRINGS PONDS WATER QUALITY DATA  
MAXIMUM AND MINIMUM VALUES OF SELECTED PARAMETERS  
(continued)

PARAMETER <sup>a</sup>	SAMPLE STATION <sup>b</sup>									
	SS-27		SS-28		SS-29		PS-11A		PS-12	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Flow (cfs)	1.8	1	168	.9	314	19.3	8.2	3.2	134	10.0
Temperature (°C)	23	6.0	17	0.0	18	0.0	21	2.0	24	0.5
pH (s.u.)	6.9	6.3	8.1	7.2	8.2	7.4	8.6	6.6	9.7	7.2
SC (umhos/cm @ 25°C)	2160	1420	1420	226	701	270	773	443	641	385
TSS	85	47	40	2	18	2	5	(c)	17	(c)
SO <sub>4</sub>	1160	609	622	38	263	58	185	103	168	102
Nitrate	3.20	0.60	3.9	0.49	3.6	0.50	6.8	(c)	6.6	(c)
Alkalinity	118	96	171	71	169	66	150	82	129	40
Hardness	1180	675	633	118	266	119	284	30	264	79
AS (T)	0.128	0.0017	0.018	0.002	0.032	0.004	0.023	0.0062	0.018	0.0015
Cd (T)	(c)	(c)	0.002	0.000	0.003	0.000	(c)	(c)	0.0014	(c)
Cu (T)	0.190	0.025	0.085	0.005	0.122	0.013	0.072	(c)	0.139	(c)
Cu (D)	0.075	(c)	<0.075	0.007	<0.075	0.010	0.023	(c)	0.051	(c)
Pb (T)	(c)	(c)	0.008	0.001	0.045	0.001	.0072	(c)	0.017	(c)
Fe (T)	54.2	13.5	1.51	0.024	0.868	0.175	0.179	0.025	1.43	0.107
Fe (D)	37.5	6.49	0.064	0.009	0.064	0.014	0.055	(c)	0.215	(c)
Zn (T)	0.547	0.243	0.304	0.026	0.040	0.007	0.202	(c)	0.431	0.024
Zn (D)	0.567	0.240	0.027	0.006	0.120	0.006	0.186	(c)	0.376	(c)

(a) Values in mg/L unless otherwise noted: (T) is total; (D) is dissolved.

(b) Sample station locations shown on Figure 1-2.

(c) Minimum below detection.

\* 1984-1986 Period of Record



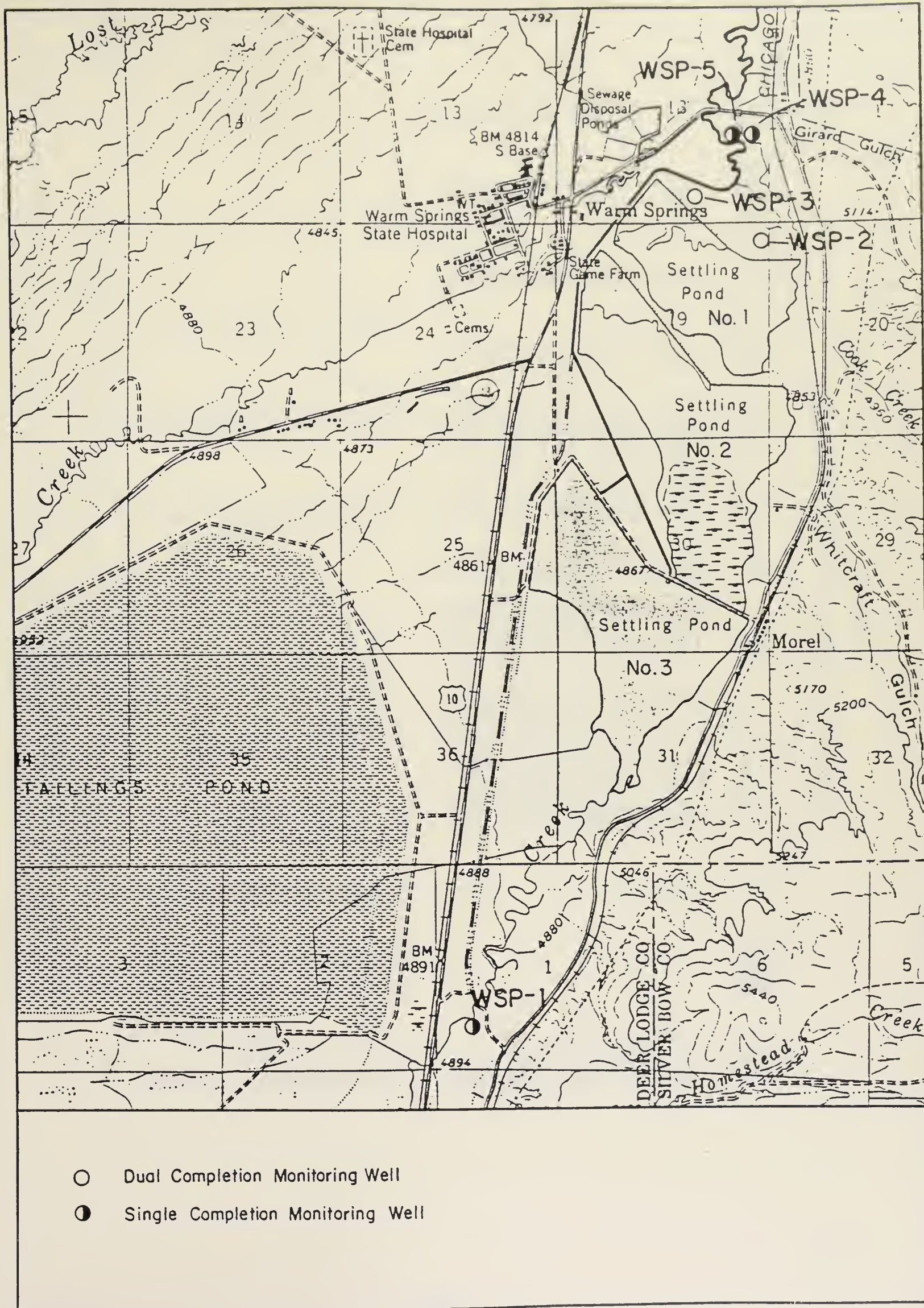


FIGURE 1-3. Existing Ground Water Monitoring Sites.

TABLE 1-3

## SILVER BOW CREEK CERCLA R1 GROUND WATER QUALITY DATA

07/15/87

PAGE 1

WELL NUMBER	CROSS REFERENCE NUMBER	LEGAL LOCATION	SAMPLE DATE	SAMPLE TIME	LAB NUMBER	SAMPLING METHOD	STATIC WATER LEVEL		PHYSICAL PARAMETERS	
							Feet below MP	Measuring Point	Water Temperature (C)	Field pH (S.U.)
WSP-1		T04N R10W S01 C8D	12/19/85	1500	W 3058	PUMPED	3.5	T0C	8.0	7.8
WSP-1		T04N R10W S01 C8D	01/09/86	0930	W 3114	PUMPED	3.8	T0C	10.0	6.8
WSP-1	BLK	T04N R10W S01 C8D	01/09/86	0940	W 3115	BLANK	NA	NA	12.0	7.7
WSP-1	DUP	T04N R10W S01 C8D	01/09/86	0945	W 3116	PUMPED	3.8	T0C	7.5	6.9
WSP-2A		T05N R09W S19 AA	12/19/85	1630	W 3060	PUMPED	2.0	T0C	6.0	7.1
WSP-2A		T05N R09W S19 AA	01/09/86	1200	W 3119	PUMPED	FROZEN	T0C	7.0	6.7
WSP-28		T05N R09W S19 AA	12/19/85	1600	W 3059	PUMPED	4.9	T0C	5.5	6.6
WSP-28		T05N R09W S19 AA	01/09/86	1215	W 3120	PUMPED	5.0	T0C	6.5	6.4
WSP-3A		T05N R09W S18 DDC	12/20/85	1000	W 3073	PUMPED	5.3	T0C	8.0	7.3
WSP-3A	DUP	T05N R09W S18 DDC	12/20/85	1030	W 3074	PUMPED	5.3	T0C	8.0	7.3
WSP-3A		T05N R09W S18 DDC	01/09/86	1115	W 3118	PUMPED	5.4	T0C	9.0	6.8
WSP-38		T05N R09W S18 DDC	12/20/85	0930	W 3072	PUMPED	5.0	T0C	7.0	7.3
WSP-38		T05N R09W S18 DDC	01/09/86	1050	W 3117	PUMPED	5.3	T0C	8.0	6.8
WSP-4		T05N R09W S18 D8C	12/20/85	1130	W 3075	PUMPED	6.4	T0C	5.0	7.1
WSP-4	BLK	T05N R09W S18 D8C	01/09/86	1310	W 3122	BLANK	NA	NA	8.0	4.5
WSP-4		T05N R09W S18 D8C	01/09/86	1330	W 3123	PUMPED	6.7	T0C	7.0	5.9
WSP-4	DUP	T05N R09W S18 D8C	01/09/86	1335	W 3124	PUMPED	6.7	T0C	6.5	6.4
WSP-5		T05N R09W S18 D8C	12/20/85	1200	W 3076	PUMPED	6.9	T0C	5.0	7.0
WSP-5		T05N R09W S18 D8C	01/09/86	1300	W 3121	PUMPED	7.1	T0C	6.0	6.6

NOTE: Units are mg/l unless otherwise noted. \* indicates data not validated.

Identifiers: T0C - Top of Casing, MP - Measuring Point, DUP - Duplicate sample, NA - Not applicable, BLK - Blank.

TABLE 1-3 (continued)

SILVER 80W CREEK CERCLA R1 GROUND WATER QUALITY DATA 07/15/87 PAGE 2

WELL NUMBER	SAMPLE DATE	SAMPLE TIME	PHYSICAL PARAMETERS (cont'd)					Total Dissolved Solids as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	REMARKS
			Specific Conductance (umhos/cm)	Eh (mv)	Dissolved Oxygen (mg/l)	Total					
WSP-1	12/19/85	1500	350	+120	5.5	140	140	0			
WSP-1	01/09/86	0930	344	+190	5.6	146	146	0			
WSP-1 8LK	01/09/86	0940	7.8	+185	6.6	2.0	2.0	0			
WSP-1 DUP	01/09/86	0945	353	+162	5.7	142	142	0			
WSP-2A	12/19/85	1630	1080	+15	0.9	188	188	0			
WSP-2A	01/09/86	1200	850	+90	1.3	188	188	0			
WSP-28	12/19/85	1600	2120	-40	1.3	204	204	0			
WSP-2B	01/09/86	1215	1650	-20	2.0	200	200	0			
WSP-3A	12/20/85	1000	1830	+130	1.8	256	256	0			
WSP-3A DUP	12/20/85	1030	1800	+20	1.3	260	260	0			
WSP-3A	01/09/86	1115	1810	+90	1.5	260	260	0			
WSP-3B	12/20/85	0930	2110	+135	2.7	252	252	0			
WSP-3B	01/09/86	1050	2070	+160	1.1	256	256	0			
WSP-4	12/20/85	1130	705	+145	2.7	196	196	0			
WSP-4 8LK	01/09/86	1310	2.6	+250	5.8	2.0	2.0	0			
WSP-4	01/09/86	1330	680	+250	2.8	200	200	0			
WSP-4 DUP	01/09/86	1335	653	+222	2.8	200	200	0			
WSP-5	12/20/85	1200	1720	-50	2.0	204	204	0			
WSP-5	01/09/86	1300	1780	-130	1.8	208	208	0			

NOTE: Units are mg/l unless otherwise noted. \* indicates data not validated. N.D. = Not determined.



TABLE 1-3 (continued)

SILVER BOW CREEK CERCLA RI GROUND WATER QUALITY DATA

07/15/87

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WELL NUMBER	SAMPLE DATE	SAMPLE TIME	CATION/ANION BALANCE			COMMON IONS:						
			Total Cations (meq/l)	Total Anions (meq/l)	Percent Difference	Calcium	Potassium	Magnesium	Sodium	Sulfate	Chloride	Fluoride
WSP-1	12/19/85	1500	4.1	4.9	-17.3	41.7	2.69	7.30	31.9	83	12.0	1.3
WSP-1	01/09/86	0930	4.4	3.9	12.0	41.7	3.35	7.56	36.4	30	12.3	0.34
WSP-1 BLK	01/09/86	0940		0.1		<0.45	<0.51	<0.24	<0.070	1.4	0.10	<0.50
WSP-1 DUP	01/09/86	0945	4.3	3.8	12.3	42.3	3.45	7.66	34.2	29	12.5	0.30
WSP-2A	12/19/85	1630	14.5	13.8	4.9	195	4.71	41.6	28.3	459	10.4	0.59
WSP-2A	01/09/86	1200	13.3	13.6	-2.2	174	5.21	40.1	25.4	456	10.9	<0.50
WSP-28	12/19/85	1600	36.2	35.3	2.5	449	12.4	106	54.3	1480	15.4	2.7
WSP-28	01/09/86	1215	26.6	24.7	7.4	314	11.0	30.0	43.3	980	11.5	1.9
WSP-3A	12/20/85	1000	31.8	25.7	21.2	467	8.22	86.0	25.5	975	8.4	0.60
WSP-3A DUP	12/20/85	1030	32.9	26.7	20.8	486	7.00	90.3	22.8	1020	8.3	0.53
WSP-3A	01/09/86	1115	28.1	26.5	5.9	407	4.75	85.7	13.5	1010	9.0	<0.50
WSP-3B	12/20/85	0930	34.5	36.8	-6.5	471	8.43	92.9	70.2	1510	10.8	0.72
WSP-3B	01/09/86	1050	35.1	32.7	7.1	486	8.12	106	42.3	1320	2.1	0.63
WSP-4	12/20/85	1130	12.9	10.8	17.7	192	4.01	31.3	13.4	325	5.7	1.0
WSP-4 BLK	01/09/86	1310		0.1		<0.45	<0.45	<0.24	<0.90	1.4	0.50	<0.50
WSP-4	01/09/86	1330	10.1	9.4	7.2	141	4.03	29.1	12.6	252	5.5	0.54
WSP-4 DUP	01/09/86	1335	9.4	9.8	-4.2	130	4.13	27.3	12.8	271	6.0	0.52
WSP-5	12/20/85	1200	34.3	25.6	29.0	513	8.85	85.9	28.6	1020	11.4	1.6
WSP-5	01/09/86	1300	24.0	23.9	0.4	339	7.80	67.8	27.0	932	10.4	0.85

NOTE: Units are mg/l unless otherwise noted. \* indicates data not validated.

TABLE 1-3 (continued)

SILVER BOW CREEK CERCLA RI GROUND WATER QUALITY DATA 07/15/87 PAGE 4

## METALS:

WELL NUMBER	SAMPLE DATE	SAMPLE TIME	Arsenic Dissolved	Cadmium Dissolved	Copper Dissolved	Iron Dissolved	Lead Dissolved	Zinc Dissolved
WSP-1	12/19/85	1500	<0.0075	0.00070	<0.0090	<0.053	<0.0014	<0.011
WSP-1	01/09/86	0930	0.0047	0.00010	0.0090	<0.051	<0.0013	<0.0050
WSP-1 BLK	01/09/86	0940	<0.0016	0.00010	<0.0060	<0.051	<0.0013	0.010
WSP-1 DUP	01/09/86	0945	0.0043	0.00060	0.0090	<0.051	0.033	0.012
WSP-2A	12/19/85	1630	<0.0075	0.0013	<0.0090	<0.053	<0.0014	<0.011
WSP-2A	01/09/86	1200	<0.0042	0.00080	0.0080	0.062	<0.0018	0.015
WSP-2B	12/19/85	1600	0.165	0.0014	0.038	62.9	<0.0014	0.387
WSP-2B	01/09/86	1215	0.244	0.0014	0.016	59.7	<0.0013	0.246
WSP-3A	12/20/85	1000	<0.0061	0.00040	<0.0090	0.104	<0.0014	<0.011
WSP-3A DUP	12/20/85	1030	<0.0061	0.00050	<0.0060	0.128	0.0054	0.0050
WSP-3A	01/09/86	1115	<0.0042	0.00060	<0.0060	0.177	<0.0018	0.0080
WSP-3B	12/20/85	0930	<0.0075	0.00060	<0.0090	<0.053	0.0044	<0.011
WSP-3B	01/09/86	1050	<0.0042	0.00070	<0.0060	0.064	<0.0018	0.022
WSP-4	12/20/85	1130	<0.0061	0.0010	<0.0060	<0.053	0.019	0.017
WSP-4 BLK	01/09/86	1310	<0.0042	0.00060	<0.0060	<0.051	<0.0018	0.0060
WSP-4	01/09/86	1330	<0.0042	0.00030	<0.0060	<0.051	0.0027	0.019
WSP-4 DUP	01/09/86	1335	<0.0042	0.00080	<0.022	<0.063	0.0018	<0.015
WSP-5	12/20/85	1200	0.018	0.0019	<0.011	1.64	<0.0014	0.105
WSP-5	01/09/86	1300	0.027	0.00080	<0.011	1.48	<0.0018	0.047

NOTE: Units are mg/l unless otherwise noted. \* indicates data not validated.

was not exceeded in discharges to the upper Clark Fork. Waters of the Mill-Willow Bypass exhibited chronic aquatic life toxicity with respect to copper and zinc concentrations, and acute aquatic life toxicity with respect to copper concentrations. Silver Bow Creek and the Opportunity Ponds surface discharges are the principal sources of contaminants for the pond system. The majority of the sulfate, copper, iron, lead, and zinc loads into the Clark Fork over the initial EI study period were from the Pond 2 discharge. Although the Mill-Willow Bypass contributed only one percent of the total flow to the upper Clark Fork, it significantly degraded the water quality of the river, providing over ten percent of the cadmium, iron, and sulfate loads during the period.

Ground water downgradient of the Warm Springs Ponds and the Opportunity Ponds is contaminated, frequently exceeding Federal drinking water standards for arsenic, fluoride, iron, and sulfate. This contaminant plume extends at least one-half mile downstream of the Warm Springs Ponds, but no apparent or immediate threat to public health is documented. No measurable effects of contaminated ground water inflow to the Clark Fork River were found during the study period. Ground water from both the Opportunity Ponds and the pond areas are the main sources of contaminant inflow to the Mill-Willow Bypass.

An evaluation of the remaining useful life of the Warm Springs Ponds treatment system indicates that incoming sediment loads are the principal controlling factor, and suggests that the life of the pond system could exceed 100 years under existing operating conditions. The Pond sediments have some of the highest concentrations of toxic metals found anywhere in the area, however, and pose a long-term potential threat to the water quality of the Clark Fork River.

The metals-removal efficiencies of the pond system during the initial RI study period exhibited seasonal variations. Overall removal efficiencies were about 87% for cadmium, 73% for lead, 65% for copper, 61% for zinc, 58% for iron, and 35% for arsenic. During the summer months the ponds showed high metals removal efficiencies, primarily due to the low input rates and higher pH. The drop in pH experienced during the winter months allowed



more dissolved cadmium, copper, and zinc to pass through the ponds without being precipitated, resulting in lower metals removal efficiencies. Because the initial RI was undertaken during a period of drought and low stream flows, the influence of typically high spring runoff inflows to the pond system was not thoroughly evaluated.

Subsequent to initial RI activities in and around the Warm Springs Ponds, additional but limited surface water quality data were collected above and below the pond system during 1986 (CH2M HILL, 1987b). These data are summarized on Tables 1-4 and 1-5.

#### 1.4 RECOMMENDED STUDIES

Rationale and justification for performing investigations described in this FOP are presented in greater detail in the Draft Silver Bow Creek Selected Data Gaps Study Plan (CH2M Hill, 1987a). These rationale and investigations are an outgrowth of feasibility study planning completed by CH2M Hill late in 1986, following review of available initial RI data and draft reports (e.g. MultiTech, 1987). The reader is referred to both the draft work plan prepared by CH2M Hill (1986), and the draft study plan for "Selected Data Gaps" identified and referenced above for more detail.

MultiTech (1987) identified several additional investigations which may be necessary to complete CERCLA feasibility studies for the Warm Springs Ponds system. These recommendations include the following:

- o Determination of the effect on the Clark Fork River of high flow bypass of the pond system by way of the Mill-Willow Bypass, especially the effects of sediment transport.
- o Additional characterization of ground water contaminant plumes identified during the initial RI studies will be necessary to better define their severity and extent. At this time, contaminant plumes have been identified both below Pond 1 and between the west side of the pond system and the Mill-Willow Bypass (Figure 1-1).

TABLE 1-4  
WARM SPRINGS PONDS  
LOW FLOW CONDITIONS  
MAY 20-21, 1986

Parameter <sup>a</sup>	Sampling Stations				
	PS-12	SS-19	SS-25	SS-28	SS-29
Flow (cfs)	96	93.6	72	66	247
pH (units)	9.0	7.9	7.5	7.7	8.1
Specific Conductance (umhos/cm)	386	256	268	355	361
Sulfate	102	61	79	78	98
Dissolved Arsenic	<0.01	0.011	0.038	<0.01	0.02
Total Arsenic	0.011	0.02	0.038	<0.01	0.018
Dissolved Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Total Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Lead	<0.005	0.0013	<0.005	<0.005	0.002
Total Lead	<0.005	<0.05	<0.005	<0.005	0.003
Dissolved Copper	0.012	0.056	0.029	0.0085	0.018
Total Copper	0.031	0.160	0.043	0.021	0.038
Dissolved Iron	0.031	0.051	0.188	0.089	0.091
Total Iron	0.302	0.957	0.432	0.279	0.509
Dissolved Zinc	0.594	0.180	0.052	0.051	0.04
Total Zinc	0.111	0.499	0.052	0.174	0.102

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<sup>a</sup> Units are mg/l unless otherwise noted.

TABLE 1-5  
WARM SPRINGS PONDS  
HIGH FLOW CONDITIONS  
MAY 30 - JUNE 1, 1986

Parameter <sup>a</sup>	Sampling Stations				
	PS-12	SS-19	SS-25	SS-28	SS-29
Flow (cfs)	186	192	269	415	872
pH (units)	9.0	8.1	8.4	8.1	8.7
Specific Conductance (umhos/cm)	343	206	110	148	202
Sulfate	78	32	22	22	35
Dissolved Arsenic	0.02	0.03	0.039	<0.01	0.018
Total Arsenic	0.021	0.039	0.052	0.017	0.025
Dissolved Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Total Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Lead	<0.005	0.0016	<0.005	0.006	0.0039
Total Lead	0.0096	0.017	0.0096	0.012	0.024
Dissolved Copper	0.029	0.054	0.029	0.025	0.025
Total Copper	0.057	0.129	0.057	0.085	0.103
Dissolved Iron	0.157	0.099	0.157	0.117	0.126
Total Iron	1.49	0.876	1.49	0.84	1.36
Dissolved Zinc	0.153	0.087	0.153	0.028	0.027
Total Zinc	0.075	0.216	0.075	0.075	0.069

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<sup>a</sup> Units are mg/l unless otherwise noted.

- c Pond bottom sediment characterization should be defined in more detail, inasmuch as limited sampling during the initial RI identified sediments with extremely high metals concentrations. Greater definition is necessary to progress to necessary feasibility studies at this site.
- o Pond algal studies were recommended to better establish the relationship between pond algal populations and water quality in, and discharging from, the pond system.
- o Geochemical computer modeling was also recommended to better evaluate the mechanisms and metal-phase distributions within the pond system.

The first three recommended studies described above are included in this phase of additional remedial investigation. This FOP addresses the procedures whereby additional data will be collected concerning the ground water contaminant plumes and pond bottom sediment characterization. A separate FOP addresses planned flood modeling activities for Silver Bow Creek and the Warm Springs Ponds area.

Neither pond algal studies nor geochemical computer modeling are planned at this time, nor are they addressed further in this FCP. This is because intensive consideration given to the problem subsequent to completion of the initial RI report (MultiTech, 1987) resulted in the determination that "treatability" tests will provide adequate data for feasibility studies on the ponds. Therefore, these treatability studies are addressed in this FOP in lieu of the previously recommended algal studies and geochemical computer modeling.



## 2.0 QUALITY ASSURANCE/QUALITY CONTROL

An objective of the sampling to be completed as part of this investigation is to obtain data of known quality. To meet this objective, a Quality Assurance Protection Plan (QAPP, CH2M HILL, 1987b) has been developed; QA steps specific to this FOP are described in Table 2-1. The following general QA requirements must be met during this study:

- o Strict chain-of-custody must be maintained for all samples collected, from time of collection to the time of completion of all analyses. Section 4.0, "Documentation and Field Observations" contains further information on this subject.
- o All data must be of known quality. Field blanks, sample duplicates, and control samples will address the quality of data collected. To meet data quality objectives, several QA/QC parameters will be addressed, including comparability, completeness, representativeness, accuracy, and precision. Further discussion of QA/QC parameters is contained in the project QAPP (CH2M HILL, 1987b).

Targets for precision and accuracy for chemical contaminant measurements have been set at 90 percent confidence with a plus or minus 10-percent deviation (see project QAPP). These targets have been established for laboratory analysis of chemical concentrations.

TABLE 2-1  
QA/QC CONSIDERATIONS FOR SEDIMENT, SURFACE WATER AND GROUND WATER SAMPLING:  
WARM SPRINGS TREATMENT PONDS

1. The Document Control Officer (DCO) will be properly trained in document control and personally responsible for all document custody.
2. The collection of specific descriptive or semi-quantitative data will always be performed by the same person(s) as specified in the appropriate Standard Operation Procedure (SOP) (Appendix A).
3. Standard operating procedures for field tasks will be followed (see Appendix A). Any deviations from SOPs which may be necessitated by field conditions must be approved by the DCO and noted in the logbook. Any changes will be relayed to the CH2M HILL Site Project Manager (SPM) for approval.
4. Any serialized documents that are inadvertently destroyed must be recorded in the logbook as destroyed.
5. Any sampling equipment used for more than one sampling unit will be decontaminated between samples in accordance with the appropriate SOP to prevent cross contamination.
6. Blind field replicate samples will be inserted into the sample train at a frequency of one per day per sampling team, or one in ten (one in twenty for sediment), whichever results in the greatest number of QA/QC samples.
7. Field bottle blanks will be inserted into the sample train at a frequency of one per day per sampling team, or one in ten (one in twenty for sediment), whichever results in the greatest number of QA/QC samples.
8. Field cross contamination blanks, where applicable, will be inserted into the sample train at a frequency of one per day per sampling team, or one in ten (one in twenty for sediment), whichever results in the greatest number of QA/QC samples.
9. Blind field standard samples will be inserted into the sample train at a minimum frequency of one per day per sampling team or one in ten (one in twenty for sediment), whichever results in the greatest number of QA/QC samples.
10. Trip blanks will be inserted into the sample train when sampling for organic parameters at a minimum frequency of one per shipped sample cooler.

Further discussion of field and laboratory quality control requirements are contained in NETSOP-13 (Appendix A), the project QAPP (CH2M HILL 1987b), and the project Laboratory Analytical Protocol (LAP) (CH2M HILL 1987c).

### 3.0 SAMPLING AND MEASUREMENT

Data collected under this Field Operations Plan are necessary to evaluate various remedial alternatives for the Warm Springs Treatment Ponds during the FS. In general, the objective of this work plan is to collect data that can be used to evaluate the effectiveness of each alternative in mitigating impacts of past mining activities in the area.

Sampling of four media (surface water, sediment, pore water, and ground water) are discussed separately in the sections below, as is the treatability testing.

#### 3.1 SURFACE WATER SAMPLING

##### 3.1.1 Purpose of Surface Water Sampling

Characterization of diurnal fluctuations of water quality within the Warm Springs Treatment Pond system is necessary to determine the ranges of treatment that may be necessary in the pond system within a short period of time (e.g., 24 hours). Also, by performing sampling episodes during each season it will be possible to determine the range of treatment necessary during an annual cycle. This information is needed to determine the size and type of treatment system that may eventually be constructed.

Surface water sampling events will consist of obtaining samples every two hours at 13 sites within the Warm Springs Treatment Ponds system during a 24-hour period. One sampling episode will be completed during each season for a total of four sampling episodes. It is anticipated sampling will be completed during July, September, January and during the time period which coincides with the greatest biomass in the pond system.

The greatest biomass in the pond system is expected to occur during the time when the ponds warm up after ice melt, typically during April, May, or June. Weekly and bi-weekly measurements of turbidity of the outflow of the



pond system will be made to ascertain the time of sampling coinciding with peak biomass in the pond system. Turbidity measurements completed as part of this work task will be performed in accordance with NETSOP-35 (Appendix A).

### 3.1.2 Parameters of Interest

A major objective of this sampling is to determine if there is a shift in dissolved and total metals concentrations during a 24-hour period due to biological changes in the pond system. It is anticipated that the pH of the water in the ponds will change by at least 1 S.U. during a 24-hour sampling period. To assess these suspected changes in the pond system, the parameters listed in Table 3-1 will be analyzed during the study.

Acid soluble analyses of metals parameters are also of interest owing to the relationship between U.S. EPA's aquatic criteria and this type of analysis. Determination of the variability of acid soluble metals concentrations in the pond system is necessary to evaluate several of the remedial alternatives for the pond system.

Other parameters listed in Table 3-1 are included to aid in the analysis of metals data and to characterize biota concentrations over time. The number and types of samples that will be collected during the diurnal sampling episodes are presented in Table 3-2.

### 3.1.3 Sampling Locations

Locations at which samples will be obtained are listed in Table 3-3 and are shown on Figure 3-1. It is anticipated that these sites will provide adequate spatial definition to determine if there are significant diurnal changes in the pond system and where they occur.

### 3.1.4 Sampling Procedures

Each sampling crew will have the necessary equipment for sampling, field measurements, and health and safety, as identified in Table 3-4.



TABLE 3-1  
Warm Springs Ponds 24-Hour  
Sampling Event Water Quality Parameters

<u>METALS *</u>	<u>OTHERS</u>
Copper	Calcium
Iron	Sodium
Zinc	Potassium
Lead	Magnesium
Aluminum	Sulfate
Cadmium	Total Suspended Sediment
Arsenic	Hardness
Manganese	Alkalinity
	Carbonate + Bicarbonate
	Chloride
	Phytoplankton
	Chlorophyll "a"
<u>FIELD PARAMETERS</u>	
Discharge	
Temperature	
SC	
pH	
DO	

\* Analyzed for total, acid soluble, and dissolved constituents.

TABLE 3-2  
SUMMARY OF SURFACE WATER SAMPLE  
QUANTITIES AND TYPES

	TYPE OF ANALYSIS			
	TOTAL METALS [a]	ACID SOLUBLE METALS [a]	DISSOLVED METALS [b]	OTHERS [c]
Natural Samples	624	624	624	624
Field Replicates	52	52	52	52
Field Standards	52	52	52	52
Bottle Blanks	52	52	52	52
Cross-Contamination Blanks	52	52	52	52

[a] Parameters include: copper, iron, zinc, lead, arsenic, cadmium, manganese, and aluminum.

[b] Parameters include: copper, iron, zinc, lead, arsenic, cadmium, manganese, and aluminum.

[c] Parameters include: calcium, magnesium, sodium, potassium, total suspended solids, hardness, alkalinity (as carbonate and bicarbonate), sulfate, chloride, phytoplankton, and chlorophyll "a".

TABLE 3-3  
Sample Locations\* for 24-Hour Sampling  
in the Warm Springs Ponds

- |   |   |
|---|---|
| 1. Silver Bow Creek above upper<br>pH Shack | 7. Pond 2, near-shore, shallow<br>water               |
| 2. Silver Bow Creek below upper<br>pH Shack | 8. Pond 2 discharge to Mill-Willow<br>Bypass          |
| 3. Pond 3, center, deep water               | 9. Pumpback from Pond 1 into Pond<br>2                |
| 4. Pond 3, near-shore, shallow<br>water     | 10. Wildlife Ponds discharge to<br>Mill-Willow Bypass |
| 5. Pond 3 discharges to Pond 2<br>(2 sites) | 11. Pond 3 discharge to Wildlife<br>Ponds             |
| 6. Pond 2, center, deep water               | 12. Wildlife Ponds                                    |

\* Locations shown on Figure 3-1

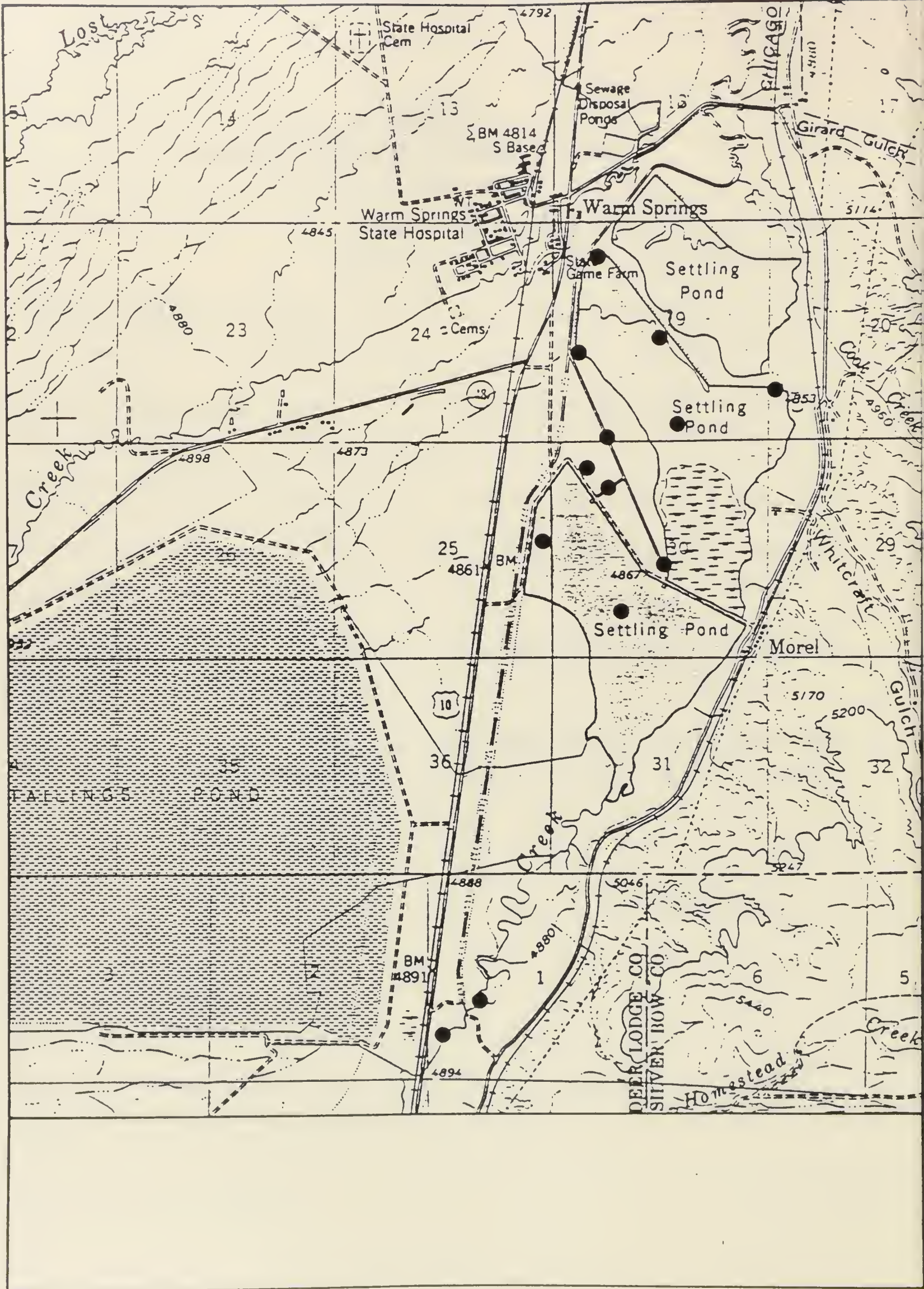


FIGURE 3-1. Surface Water Sampling Sites , 24-hour Diurnal Sampling Episodes.



TABLE 3-4  
SURFACE WATER  
SAMPLING, MEASUREMENT, AND SAFETY EQUIPMENT:

Conductivity Meters (6)	Specific Conductivity Standards (6 sets)
Dissolved Oxygen Meter (6)	Calculators (6)
pH Meters (6)	Paper Towels (4 cases)
Vermiculite (28 bags; 1 yd <sup>3</sup> each)	DH-48 Integrated Samplers & Bottles (3 sets)
pH Standards (6 sets)	Filtration Apparatuses (6)
Thermometers (6)	Blue Ice (700)
Garbage Bags	Deionized Water (240 Gallons)
Wash Basins (6)	10% Dilute HNO <sub>3</sub> (72 Gallons)
Brushes (6)	Sample Bottle Checklist
1% Liquinox (24 Gallons)	Tool Kits (6)
Squeeze Bottle (12)	First-aid Kits (6)
Pygmy and/or AA meters (6)	Fire Extinguishers (6)
Stop Watches (3)	Heavy Duty Zip-Lock Bags (3300)
Hip Boots (6 pairs)	Blankets (6)
Surface Water Field Note Form (800)	Radios (6)
50' Tapes (6)	EPA Sample Tags (3300)
5-Gallon Buckets (6)	Sample ID Matrix Forms (220)
Stakes and Hammer (6 sets each)	SAS Packing List (180)
Surgical Gloves (1200 Pairs)	Federal Express Air Bills (12)
Rubber Gloves (12 Pairs)	Kemmerer Sampler (3)
USEPA QC Water Samples (48)	Sample Bottles - 1 L. (3100)
Indelible Ink Pens (50)	Chain-of-Custody Forms (150)
Nitric Acid Preservative (2500)	Ice Chests (115)
Sample Custody Seals (3300)	Lifevests (6)
Boat (3)	

Note: Where applicable, quantities include QA/QC samples.  
Spare equipment will be available in the field.

Six sampling crews will be employed during each sampling episode, with each crew being responsible for two or three sampling sites. Thus, each crew will need to complete approximately one site per hour.

Discharge at sites exhibiting flowing water will be measured during sampling by using either known stage-discharge relationships, or by measuring discharge before and after each 24-hour sampling episode in accordance with NETSOP-01 (Appendix A). Sampling will be conducted in accordance with NETSOP-34 at all pond locations and in accordance with NETSOP-03 at all sites exhibiting flowing water. Sample preparation and field measurements will be made in accordance with NETSOP-04, NETSOP-19, NETSOP-05, NETSOP-06, NETSOP-07, and NETSOP-08 (Appendix A).

## 3.2 SEDIMENT SAMPLING

Sediment samples will be collected from three different environments in the Warm Springs Treatment Ponds area. These include: sediments below standing water in Pond 3, Pond 2, and the Wildlife Ponds; sediments in an inactive treatment pond site (Pond 1); and surficial sediments present in the diversion channel from the upper pH shack to the Mill-Willow Bypass and along the bypass itself. Analyses of sediment chemistry from the former two environments will characterize the extent, severity, and mobility of contaminants in the pond system whereas samples from the latter locations will aid in determining sources of contamination postulated to cause periodic fish kills in the upper Clark Fork River.

Sampling plans and sampling methodologies for each of these environments is described separately in this chapter.

### 3.2.1 Parameters of Interest

Metals associated with past mining activity are the primary parameters of interest in sediments to be sampled in the Warm Springs Treatment Ponds area. In addition, the relative toxicity of metals in sediments in the area is of concern for evaluating remedial alternatives during the FS. For this reason, EF toxicity analyses for metals will be completed on sediment samples collected exclusive of those obtained from the bypass area.

The site has also possibly been contaminated with organics; for this reason selected sediment samples will be analyzed for priority pollutants. A complete and accurate appraisal of the extent and severity of possible organic contamination will not be completed during this investigation. We believe it is appropriate to determine if organics contamination is present at the site prior to completing an extensive organic sampling program.

The parameter list for sediment sampling is presented in Table 3-5. A summary of the number and types of sediment samples to be obtained is presented in Table 3-6.

TABLE 3-5  
Parameter List  
Pond Bottom Sediments  
and Mill-Willow Bypass Sediments

<u>METALS (a)</u>	<u>OTHERS (c)</u>	<u>FIELD PARAMETERS</u>
Copper (b)	Sulfide	SC
Zinc (b)	Cyanide	Eh
Iron	Percent Solids	pH
Cadmium (b)	Particle Size	Depth
Arsenic (b)	Distribution	Color
Lead		
Manganese (b)		
Aluminum (b)		
Selenium		
Mercury		
Chromium		

Other parameters to be determined include:

- 1) EP Toxicity concentrations for metals for pond bottom sediments only.
- 2) Priority pollutants on selected samples obtained from Ponds 2 and 3 and Wildlife Ponds.

- (a) Analyzed for total metals for all samples collected.
- (b) Analyzed for both total and water soluble constituents in samples collected from Mill-Willow Bypass area.
- (c) Analyzed for pond bottom sediment samples only.



TABLE 3-6  
SUMMARY OF SEDIMENT SAMPLE  
QUANTITIES AND TYPES

	TYPE OF ANALYSIS				
	TOTAL METALS [a]	WATER-SOLUBLE METALS [b]	OTHERS [c]	EP TOXICITY [d]	PRIORITY POLLUTANTS [e]
Natural Samples	200	50	150	150	5
Field Replicates	11	3	8	8	1
Field Standards	11	3	8	8	1
Bottle Blanks	11	3	8	8	1
Cross-Contamination Blanks	11	3	8	8	1
Trip Blanks	0	0	0	0	1

[a] Analyzed for samples obtained from Ponds 2 and 3, Wildlife Ponds, and Mill-Willow Bypass; Priority pollutants include those specified in project LAP

[b] Analyzed for samples obtained from Mill-Willow Bypass area; Parameters include: Cu, Zn, Cd, Mn, As, and Al

[c] Analyzed for samples obtained from Ponds 1, 2, and 3 and the Wildlife Ponds; Parameters include: Percent Solids, Sulfide, Particle Size Distribution, and Total Cyanide

[d] Analyzed for samples obtained from Ponds 1, 2, and 3 and Wildlife Ponds; EP Toxicity analyses for metals only

[e] Analyzed for samples collected from Ponds 2 and 3, Wildlife Ponds, and Mill-Willow Bypass; Priority pollutants include those specified in project LAP

### 3.2.2 Sampling Locations

Sediment samples will be obtained from each of the four ponds that make up the Warm Springs Treatment Ponds system at a sampling site density commensurate with the relative size of each pond. This will result in the following number of sample sites: Pond 3 (12); Pond 2 (8); Pond 1 (6); and the Wildlife Ponds (4). In addition, sediment samples will be obtained from approximately eight transects in the Mill-Willow Bypass system.

Approximate locations of sediment sample sites in the Warm Springs Treatment Ponds area are shown on Figure 3-2.

### 3.2.3 Field Procedures

#### 3.2.3.1 Pond 3, Pond 2, and Wildlife Ponds

Sediment samples from Pond 3, Pond 2, and the Wildlife Ponds will be collected in accordance with NETSOP-31 (Appendix A). Field parameters including pH, SC, and Eh will be measured in accordance with NETSOP-36 (Appendix A).

Sampling and safety equipment to be used during the sample collection process are presented in Table 3-7.

Sediment from Pond 3, Pond 2, and the Wildlife Ponds will be collected during winter months when adequate ice cover is present to support personnel and sampling equipment. Ice cover will provide better access and control for obtaining samples as compared to working from a floating vessel. Sediment samples will be collected from discrete vertical intervals at each sample site to characterize materials in three general horizons within ponds containing water. These include a zone above the pond bottom containing flocculated sediment, the layer containing accumulated sediments, and the original pond bottom surface.

It is anticipated that sediment samples will be collected from approximately five intervals in the extracted sediment column at each sample site. These intervals will include one from the flocculated



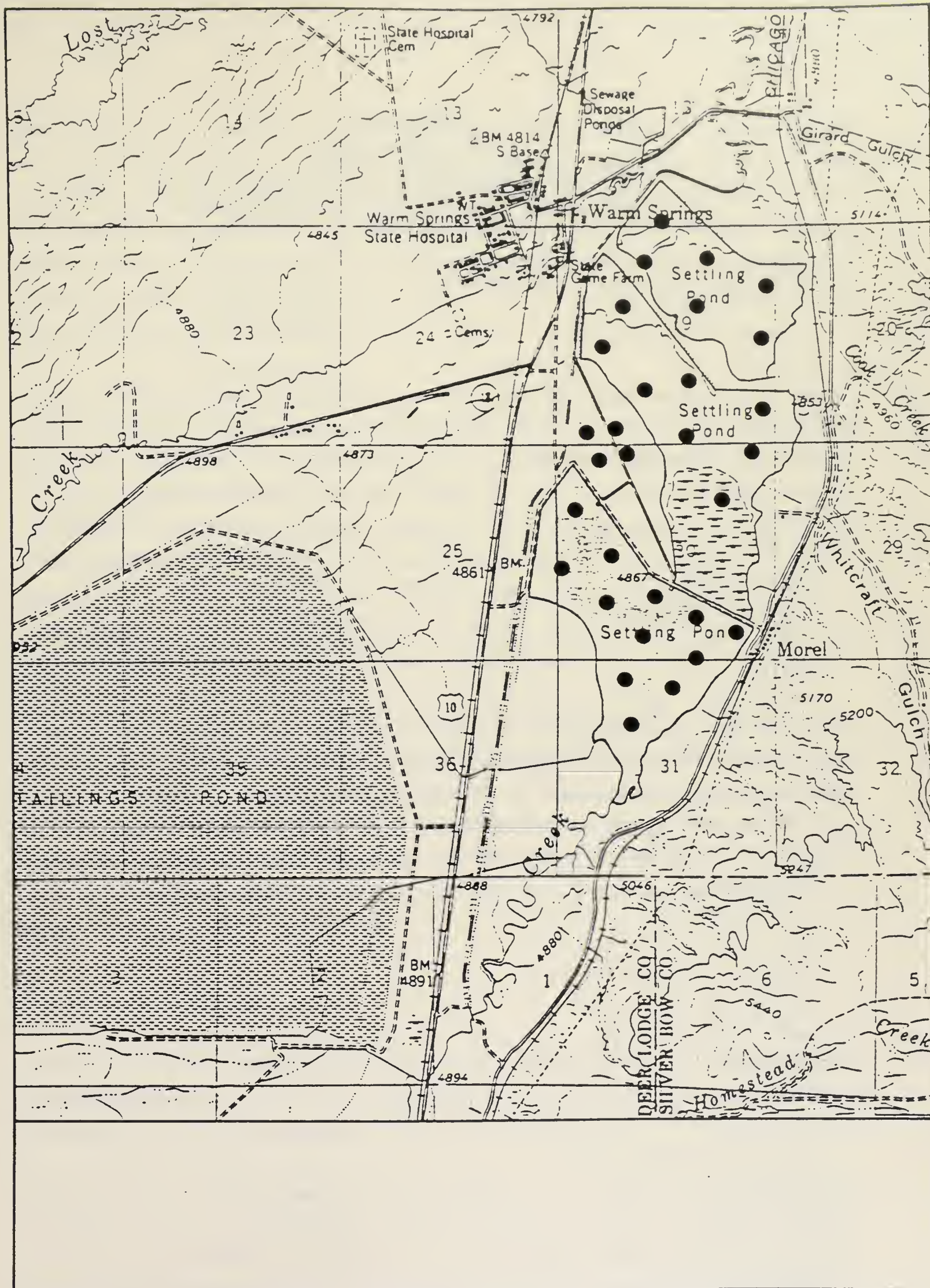


FIGURE 3-2. Approximate Locations of Pond Bottom Sediment Sampling Sites.

TABLE 3-7  
PORE WATER AND  
GROUND WATER MONITORING WELL CONSTRUCTION,  
DEVELOPMENT, SAMPLING, AND SAFETY EQUIPMENT

Conductivity Meters and Standards	Calculators
Dissolved Oxygen Meter	Paper Towels
pH Meters and Standards	Blue Ice
Frac Sand	Deionized Water
Drill Rig and Accessories	10% Dilute $\text{HNO}_3$
Thermometer	Tool Kit
Steam or Hot-water Cleaner	First-aid Kit
Wash Basins	Fire Extinguisher
Brushes	Heavy Duty Zip-Lock Bags
Liquinox	Strapping Tape
Squeeze Bottle	Blankets
5-Gallon Buckets	Radios
Surgical Gloves	Gallon Plastic Bottles
QC Standards	OTR Forms
Indelible Ink Pens	EPA Sample Tags
1 liter Poly Sample Bottles	SAS Packing List
8 oz. wide mouth glass sample bottles	Federal Express Air Bills
40 ml VOA I-Chem Bottles	Hard Hats
1 gallon Amber glass I-Chem bottles	Air Compressor
Stainless steel sharpshooter shovel	Air Hose
XRF-ATX 100	Stinger
Travel Blank	Surge Block
Nitric Acid Preservative	Screen
Sulphuric Acid Preservative	PVC Casing
Chain-of-Custody forms	Volclay Grout
Sample Custody Seals	Steel toed rubber boots
Ice Chests	Coveralls
Well Probes	Filtration Apparatuses
Bottom Caps	Blue Ice
Locking Well Caps	Sample ID Matrix forms
Pea Gravel	Rubber Gloves
Field Forms	Kimwipes
Pelletized Bentonite	Bucket Auger
Bladder Pump	Knife
Garbage bags (large)	



sediment zone, three from the accumulated sediment zone, and one from the original pond bottom surface. These proposed sampling intervals are tentative and are subject to field determinations of lithologies, field parameters, and sediment thicknesses encountered during sampling. Every attempt will be made to collect sediment samples which are representative of the sediment profile and which will provide a realistic range of the chemistry within the sediments.

Sediment samples will also be collected from two sites in Pond 3, from two sites in Pond 2 and from one site in the Wildlife Ponds for analysis of priority pollutants. A composite sample will be collected from throughout the accumulated sediments at each sampling site for this analysis. The rationale in obtaining composite samples is that the method will allow for the best determination of the presence of organic contamination. As stated previously, the intent of organic sampling during this investigation is to determine if organic contamination is present at the site, not to determine actual locations or sources of organic contamination.

Sample sites for priority pollutant analyses are tentatively located in the delta and near the downstream berms of each pond (Figure 3-2) to provide a range of expected organic concentrations in the pond bottom sediments. Actual sample sites will be determined following analysis of field data gathered during sediment sampling for inorganic parameters. Preference will be given to sites identified as exhibiting the best environment for organic contaminant accumulation.

#### 3.2.3.2 Pond 1

Sediment sampling completed at Pond 1 will be completed in accordance with NETSOP-31 (Appendix A). Field parameters, including pH, Eh, and SC will be measured according to procedures outlined in NETSOP-36.

Because Pond 1 is abandoned and is largely dry, a drill rig will be used during winter months to obtain sediment samples. Samples will be collected from approximately five intervals at each sample site. It is anticipated that four of the samples will be obtained from the accumulated sediment in

the pond and one sample will be obtained from the original sediment underlying the pond. Samples submitted for laboratory analysis of parameters listed in Table 3-5 will be field determined based on lithologies encountered, field parameter measurements, and thicknesses of sediment encountered during sampling.

The intent of the sampling program at Pond 1 is to obtain samples which will characterize the range of parameter concentrations in the accumulated sediments and to determine the chemical characteristics of the original pond bottom material. Sampling for organic contaminants at Pond 1 will not be completed because the period of use of the pond predates the operation of upstream facilities identified as known organic contaminant sources.

#### 3.2.3.3 Mill-Willow Bypass and Silver Bow Creek Diversion Channel

Sediments in the diversion channel from Silver Bow Creek to the Mill-Willow Bypass and in the bypass itself will be characterized to the end of determining metals contaminant sources believed to be responsible for periodic fish kills in the upper Clark Fork River. This will be accomplished in two interrelated phases. The first phase will include use of an X-ray fluorescence spectrometer (XRF) in accordance with NETSOP-23 (Appendix A) to provide a qualitative evaluation of the distribution and concentrations of potential metals contaminant sources in the bypass area. This effort will focus the second phase of sediment characterization in the area which includes sediment and soils sampling and analysis. Sediment and soils sampling will be completed in accordance with NETSOP-22 (Appendix A).

A screening tool such as the XRF is necessary at this site owing to the size of the bypass area and because of the presence of numerous potential metals contaminant sources. Several transects will be completed using the XRF at the site both parallel to the channels and in cross section. More frequent readings will be obtained at sites exhibiting visible mill tailings. XRF data will be analyzed to locate approximately 50 sediment and soils sample sites throughout the length of the diversion channel and the Mill-Willow Bypass to above the Pond 2 discharge into the bypass. Other sampling sites will be located in the bypass upstream of its confluence with the Silver Bow Creek diversion channel.



Samples collected will be analyzed for parameters listed in Table 3-5. Many metals listed in Table 3-5 in high concentrations are known to be toxic to fish. Sampling sites will be located based upon collected XRF data, the desire to characterize sediment chemistry areally and in cross section within the channels, and the need to quantify background sediment chemistry. Therefore, exact locations of sediment sampling sites in the Mill-Willow Bypass area cannot be identified at this time.

### 3.3 PORE WATER

Objectives of sampling pore water in accumulated sediments in the Warm Springs Treatment Ponds system are to establish a relationship between pore water chemistry and sediment chemistry, determine the mobility of arsenic in pore water within the sediments, and to determine changes in pore water chemistry vertically and spatially within the pond system.

A detailed investigation of pore water chemistry is beyond the scope of this investigation. The intent of this portion of this study is to provide a basis for evaluating the likelihood that metals are moving downward from the ponds into the underlying alluvial aquifer, and to provide data for evaluating the remedial alternative of pond removal. We anticipate this information can be obtained to the necessary level of detail with limited pore water sampling.

#### 3.3.1 Parameters of Interest

Metals contaminants associated with historic mining and milling activities are the primary parameters of interest associated with pore water sampling. Other parameters to be analyzed include those which will aid in the analysis of metals data. Table 3-8 lists parameters to be analyzed in pore water samples collected during this investigation; Table 3-9 lists sample types and quantities for pore water and ground water samples.

In addition, pore water samples will be collected for determination of arsenic speciation. These data will be compared to Eh and pH data to determine metals mobility in the pond system.

TABLE 3-8  
Warm Springs Ponds Ground Water  
and Pore Water Quality Parameters

<u>Dissolved Metals</u>	<u>Field Parameters</u>	<u>Others</u>
Copper	SC	Calcium
Iron	pH	Sodium
Zinc	Eh	Magnesium
Aluminum	DO	Potassium
Cadmium	Temperature	Sulfate
Arsenic		Chloride
Lead		Alkalinity Carbonate/Bicarbonate
Manganese		Hardness
		Nitrate plus Nitrite
		Ortho-Phosphate <sup>a</sup>
		Total Phosphorous <sup>a</sup>

Notes: (1) Selected ground water samples will be analyzed for priority pollutants.

(2) Selected pore water and ground water samples will be analyzed to speciate arsenic.

(a) Pore water only

TABLE 3-9  
SUMMARY OF SAMPLE QUANTITIES AND TYPES:  
GROUND WATER SAMPLING AND PORE WATER SAMPLING:  
WARM SPRINGS PONDS

TYPE OF SAMPLE	ARSENIC SPECIATION	SAMPLE QUANTITY		NITRATE PLUS NITRITE	PRIORITY POLLUTANTS
		DISSOLVED METALS(a)	ANIONS(b)		
Natural Samples	39	92	92	92	12
Field Replicates	7	16	16	16	2
Field Standards	0 (c)	16	16	16	2
Bottle Blanks	7	16	16	16	2
Cross-Contamination Blanks	7	16	16	16	2
Trip Blanks	0	0	0	0	2

[a] Parameters include: arsenic, cadmium, copper, lead, iron, manganese, zinc, calcium, magnesium, sodium, and potassium.

[b] Parameters include: sulfate, chloride, hardness, alkalinity (as bicarbonate and carbonate), fluoride, orthophosphate, and total phosphorous

[c] Blind field standards not available for As speciation.

### 3.3.2 Sampling Locations

Pore water samples will be collected at two sites in Pond 3 and two sites in Pond 2. Sample sites will be located following sediment sampling for inorganic parameters described in section 3.2.3.1. Sampling site locations will be based upon analysis of field data obtained during sediment sampling and upon the desire to characterize ranges in pore water chemistry expected in the pond system.

Pore water will be obtained from approximately five intervals at each sample site. The intervals will coincide with depths from which sediment samples are collected such that comparisons of chemical data can be made. Four sampling intervals will be located in accumulated sediment in the ponds; the fifth interval will intercept the original pond bottom.

### 3.3.3 Field Procedures

Pore water sampling will be completed in accordance with NETSOP-32 (Appendix A). Sampling will be completed during winter months when ice cover on the ponds will provide safe access to the sampling sites for personnel and equipment. Table 3-7 lists necessary safety and sampling equipment to perform pore water sampling.

## 3.4 GROUND WATER INVESTIGATIONS

### 3.4.1 Purpose of Ground Water Investigations

Two general areas of ground water contamination associated with the Warm Springs Pond area were identified during the initial RI (MultiTech, 1987). One area is below Pond 1 and extends to the north; a second area is located along the west side of the pond system near the Mill-Willow Bypass (Figure 3-3).

The objective of this investigation is to better characterize the vertical and horizontal extent of the contamination and to quantify its impacts on the Clark Fork River and the Mill-Willow Bypass. In addition, an assessment of the presence of organic contaminants will be completed and an evaluation of metals mobility in the ground water system will be made.



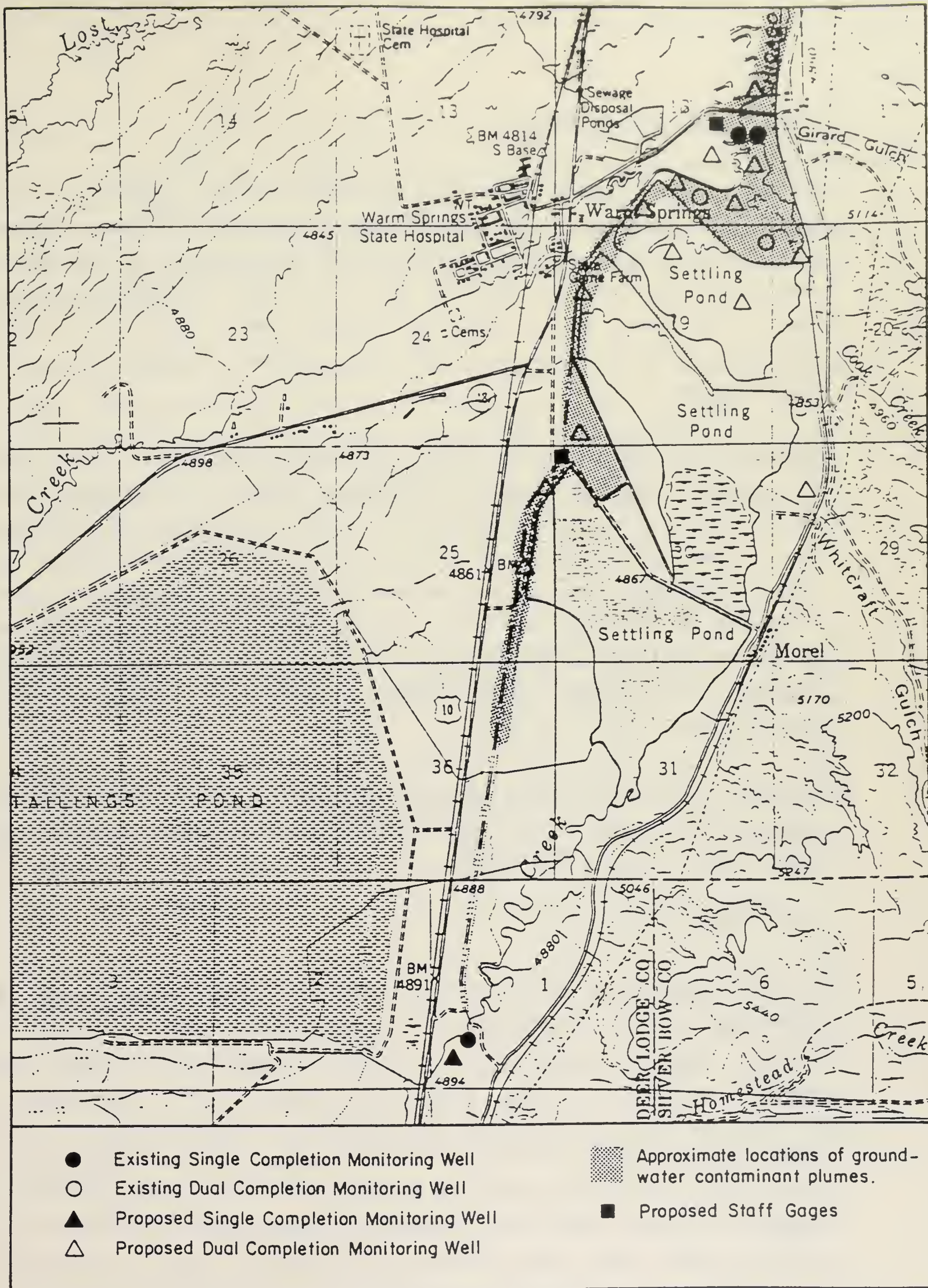


FIGURE 3-3. Ground Water Features



### 3.4.2 Parameters of Interest

Parameters of interest in this investigation are primarily metal contaminants associated with past mining activities in the area. Other parameters are being analyzed to aid in the interpretation of the metals data and to provide an assessment of potential organic contamination of the ground water system in the vicinity of the pond system. Table 3-8 contains parameters to be analyzed in ground water samples collected during this investigation.

Inorganic parameters selected for analysis were based upon data collected during the Silver Bow Creek RI (MultiTech, 1987) which indicated that concentrations of these parameters were elevated with respect to upgradient ground water quality data. Selected monitoring wells will be sampled for organic parameters owing to the documented presence of organic parameters at sources in the Silver Bow Creek drainage basin. A detailed assessment of the severity and extent of organic contamination in the Warm Springs Treatment Ponds ground water system is beyond the scope of this investigation.

Selected samples will also be submitted for analysis of arsenic speciation. These parameters will aid in evaluating the mobility of metals contaminants in the area's ground water system.

### 3.4.3 Sampling Locations

A surface geophysical survey will be completed to site approximately 15 monitoring wells in the vicinity of the pond system. The wells will be located, completed, and sampled to better delineate the horizontal and vertical extent of known areas of ground water contamination. Approximately 14 of the wells will be constructed as dual-completions. All wells including seven existing monitoring wells, will be sampled twice during this investigation; sampling episodes will occur during periods of highest and lowest ground water elevations as determined by continuous and periodic ground water level monitoring (See Section 3.3.4). Anticipated well locations are shown on Figure 3-3.

Samples for priority pollutants will be obtained from two vertical intervals at three dual-completion wells, one located upgradient of Pond 3 and two downgradient of Pond 1 (Figure 3-3). The upgradient well will serve to provide data on background water quality while samples collected from the downgradient wells will document any organic contamination exiting the pond system.

Two staff gages will be installed to characterize surface water-ground water interrelationships within the study area. One staff gage will be installed in the Mill-Willow Bypass and one will be installed in the Clark Fork River (Figure 3-3). Staff gages will be surveyed to establish a common datum from which relationships between stream stage and ground water levels can be determined.

#### 3.4.4 Field Procedures

Electromagnetic (EM) geophysical techniques will be used in the Warm Springs Pond area in accordance with NETSOP-30 (Appendix A) as an initial attempt to delineate the lateral and vertical extent of ground water contamination. EM profiling and sounding methods should work well in the Warm Springs Treatment Ponds area owing to the shallow water table present at the site (typically less than ten feet), the relatively high specific conductance values associated with the contaminated ground water (five to ten times background), and relatively easy access to the area by foot.

Approximate locations of EM transects are shown on Figure 3-4. Data generated from the EM survey will be entered into a computer data base for enhanced utilization. Analysis of these data will allow for better definition of the lateral extent of ground water contamination and to a lesser degree, the vertical extent of degraded ground water. These data will also be used to site ground water monitoring wells throughout the study area.



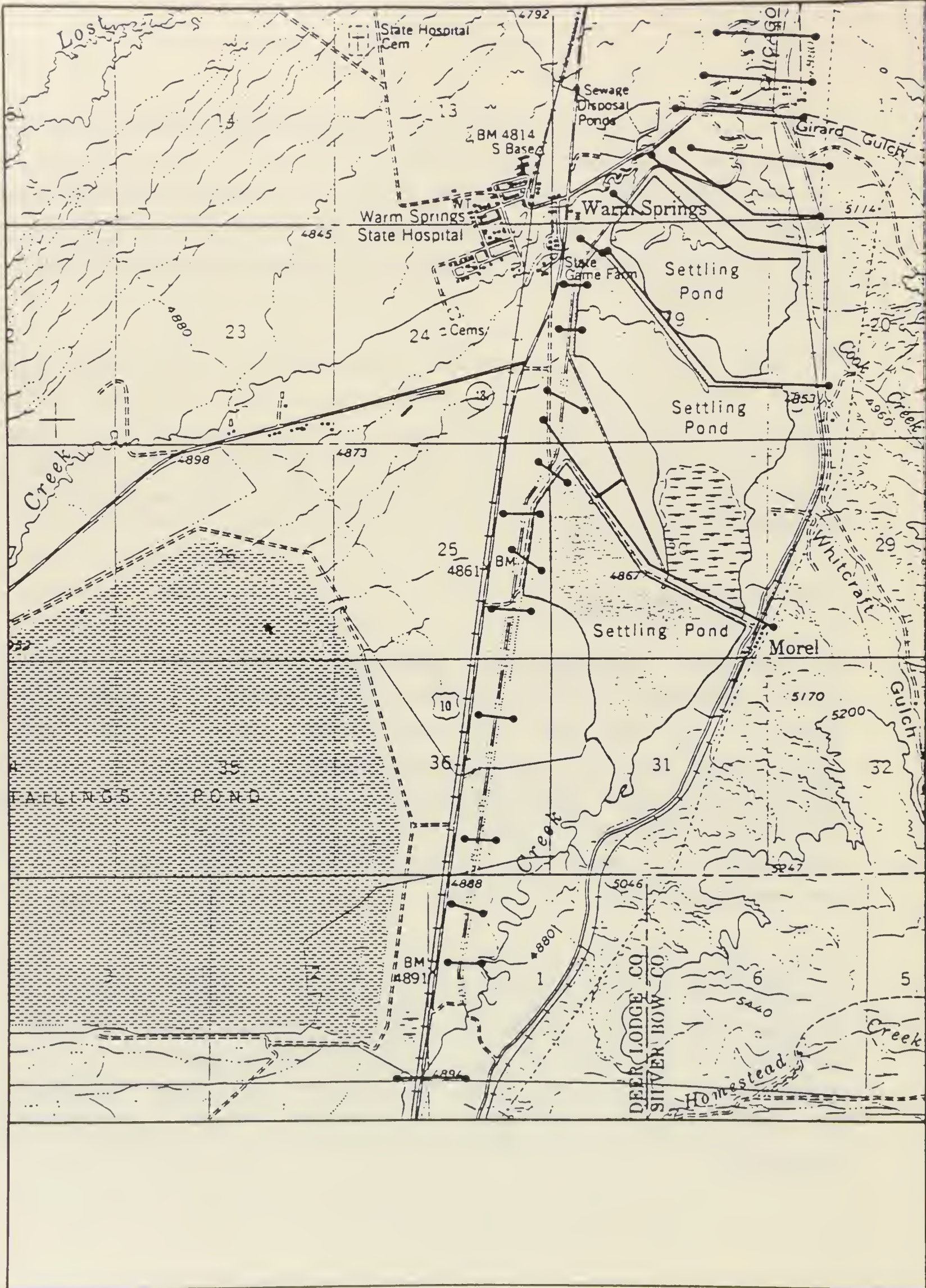


FIGURE 3-4. Approximate Locations of Electromagnetic Transects.

Monitoring well construction, well development, ground water sampling, and water level measurement will be completed in accordance with NETSOPs 16, 17, 18, and 20 (Appendix A). It is anticipated that a three-person drill crew will be necessary for monitoring well construction; a two-person crew will suffice for well development and ground water sampling.

Monitoring wells will be constructed utilizing either a cable tool or air rotary drill rig. Completion depths will be based upon geophysical data obtained previously from the site and upon field determinations of lithology and water quality field parameters. The drilling method utilized will allow for retrieval of ground water samples at discrete vertical intervals. Collected ground water samples during drilling will be analyzed for field parameters including temperature, specific conductivity, and pH. Existing RI data indicate water quality generally improves with depth in the area. For this reason, the deeper completion in each dual-completion monitoring well will be finished in zones where improved ground water quality is encountered, as determined from field parameter data.

Proposed locations for monitoring well construction (Figure 3-3) are tentative and are subject to change pending the outcome of the EM survey. In general, monitoring wells will be located where access is available to delineate the extent of known ground water contamination areas below Pond 1 and between the pond system and the Mill-Willow Bypass. In addition, a second upgradient well will be constructed in a major drainage entering the pond system from the southeast (Figure 3-3). This well will compliment an existing upgradient well located near Silver Bow Creek. This arrangement allows characterization of ground water quality entering the pond system.

Drill cuttings and water encountered during drilling activities will be disposed onsite proximal to each well site. Existing RI data indicate soils and water in the area are of such quality that alternative disposal methods are not warranted.



Monitoring wells installed during this investigation and five existing monitoring wells will be sampled twice; sampling episodes will coincide with maximum and minimum water table elevations as determined by continuous and periodic water level measurements. We believe sampling during these time periods will provide a measure of the range of chemical concentrations in the area ground water system. Samples for arsenic speciation will be collected from approximately 25% of the wells sampled including both shallow and deep completions. All ground water sampling will be completed in well in advance of any aquifer testing completed in the area.

Sample quantities and types for this work task are listed in Table 3-9. Equipment necessary to perform the monitoring well installation and sampling is summarized in Table 3-7.

One larger-diameter (approximately six-inch) well will be constructed downgradient of Pond 1 to access pumping equipment for subsequent aquifer testing. This portion of the study area provides the best access for equipment and the best opportunity to control discharge water during the test. Initial RI data (MultiTech, 1987) also indicate the area is representative of area hydrogeology. The exact site and completion depth for this well will be determined following installation of the monitoring wells and will be based upon the following criteria:

- o Location with respect to the plume emanating from within the pond system. The well will be sited to coincide with the approximate center of the plume. Rationale for this criteria is to maintain the plume onsite during the aquifer test and to provide the greatest likelihood that hydraulic parameters calculated are representative of the plume area.
- o Results of the EM survey and monitoring well installation efforts. The well will be completed in a lithologic unit determined to be the most significant water-bearing unit within the zone of contaminated ground water. This decision will be based upon EM data and field notes derived from monitoring well installation.



If additional significant water-bearing zones are encountered within the zone of contaminated ground water, a separate well will be constructed and an additional aquifer test will be performed to characterize that unit and its relationship with the upper aquifer.

The well(s) used for aquifer testing will be designed to include a screened section with a slot size conducive to the size material encountered in the water-bearing zone of interest. One of two procedures will be used to select screen size: (1) Material samples will be obtained from the zone of interest and will be analyzed for particle size gradation. The slot size will be determined based on a cumulative plot of grain size distribution; or, (2) A gravel pack will be installed commensurate with the selected slot size and in consideration of particle sizes of material encountered in the water-bearing zone.

The length of screen section emplaced into the borehole will be such that the entire saturated thickness of the water-bearing zone is intercepted. The screen will be placed into the borehole lined with driven steel casing; the steel casing will be pulled back following screen installation to expose the screen to the target aquifer. A K-packer will be installed between the top of the screen and the base of the steel casing to provide a water tight seal in the well. Figure 3-5 is a schematic of the anticipated well completion for the aquifer testing well.

Four observation wells will be installed proximal to the pumping well to provide additional access points to evaluate hydraulic response to aquifer drawdown. Two observation wells will be located at approximately 10 feet from the pumping well at right angles to each other, and the other two observation wells will be located approximately 100 feet from the pumping well in line with the observation wells constructed closer to the pumping well. The observation wells will be perforated in the same water-bearing unit as is the pumping well.

The aquifer test will consist of a 24-hour constant discharge pumping test followed by an aquifer recovery test in accordance with NETSOP-26. Aquifer parameters including transmissivity, permeability, degree of anisotropy,

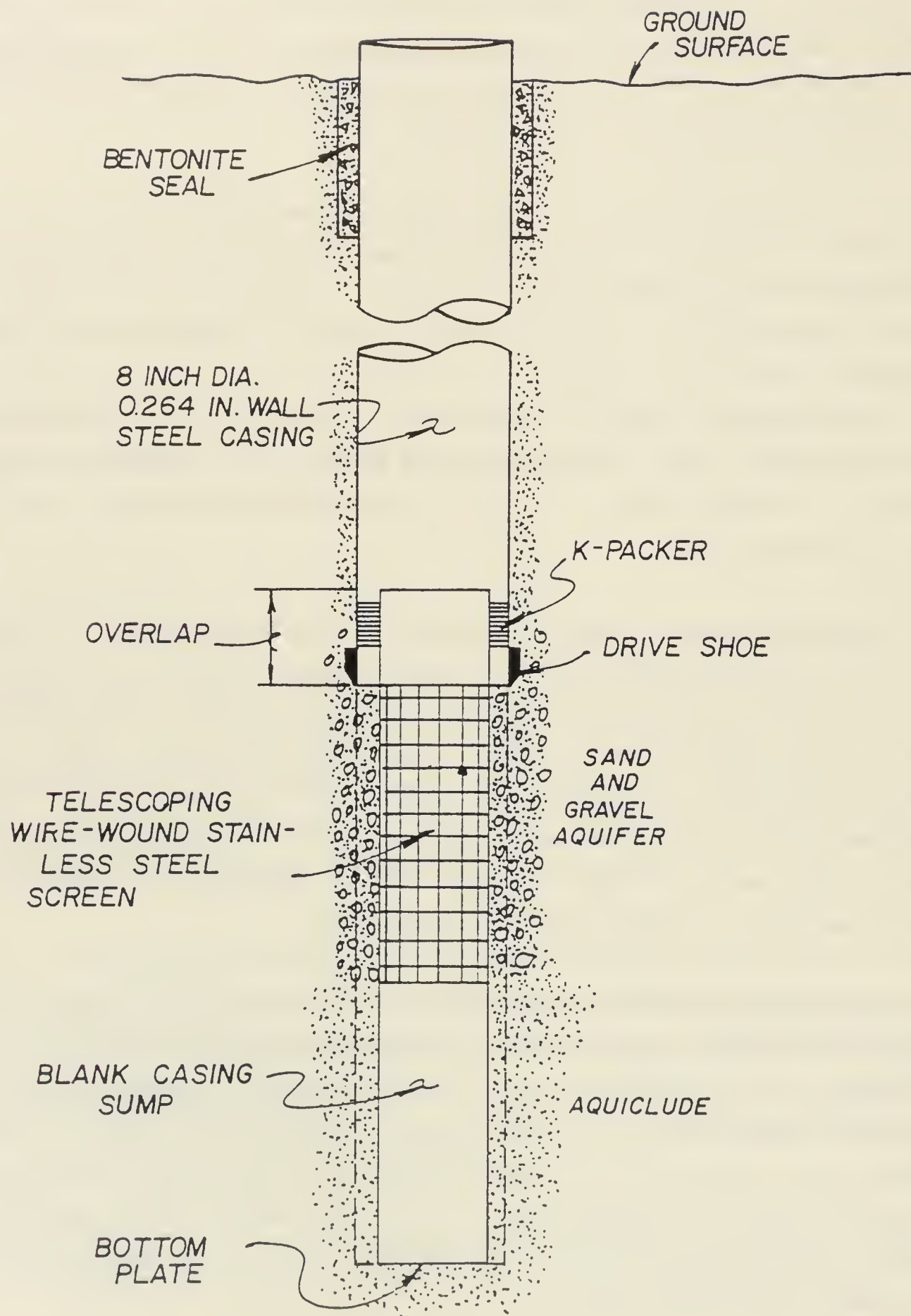


FIGURE 3-5

SCHEMATIC OF TYPICAL  
PUMPING WELL CONSTRUCTION

and storage coefficients will be determined from results of the tests. Slug tests will be performed on other monitoring wells constructed during this investigation in accordance with NETSOP-26 in an effort to determine the spatial heterogeneity of the aquifer.

All monitoring wells will be surveyed to provide locations and elevations with respect to an established datum. The two staff gages installed in area streams will be surveyed similarly.

Monthly ground water level measurements will be made at all area monitoring wells for 12 months in accordance with NETSOP-20. Two monitoring wells will be equipped with recorders to obtain a continuous record of ground water table fluctuation.

### 3.5 TREATABILITY TESTS

#### 3.5.1 Purpose of Treatability Tests

The purpose of the treatability tests is to determine which parameters must be controlled, and how they must be controlled, to maximize metal removal in a pH-controlled, settling-type system. Once these parameters are defined, the ponds can be examined to determine if they can be modified to meet and maintain these parameters. This latter step, however, is not part of the present investigation. Additional details on the treatability tests are presented in the LOP.

#### 3.5.2 Parameters of Interest

The parameter to be sampled is the water of Silver Bow Creek. Obtaining samples that are representative of pond inflow that will have to be treated is necessary if the information generated by the treatability testing is to have meaning. Therefore the timing of the sampling efforts be important, and must coincide with high metals level in the creek and a low pH. This probably occurs most frequently during fall or winter conditions.



### 3.5.3 Sampling Locations

Two water samples will be taken from Silver Bow Creek at the upper pH shack (see Figure 3-1). One will be taken during the winter when the pH is low and the dissolved metal content is high. The second sample will be taken during a runoff event. This "runoff" sample will be collected when the stream flow doubles over a one- to two-day period due to a precipitation event.

### 3.5.4 Field Procedures

Samples will be obtained using a diaphragm-type pump and placed directly into Nalgene drums. For the "winter" sample, approximately 100-200 gallons of water will be collected for the initial, small-scale tests, and approximately 400-600 gallons will be collected for the subsequent, large-scale test. The samples will be collected during the same sampling event. For the "runoff" sample, 100 to 200 gallons of water will be collected since only a limited test program is planned on this sample. Stream flow measurements will be made at the time of sampling in accordance with NETSOP-01, and field measurements made in accordance with NETSOP-05, NETSOP-06, NETSOP-07, and NETSOP-08 and NETSOP-28. A dissolved metal sample will be collected in accordance with NETSOP-04 and shipped to the laboratory in order to assess any decrease in dissolved metals concentration during shipment.

If a satisfactory runoff event does not occur by a specified time (tentatively September 30), this runoff sample will be collected from a simulated event. This will be accomplished by pumping creek water on to an area of exposed tailings and collecting the runoff in Nalgene drums.

This runoff sample will be blended with creek water to produce a final pH value of 6.5. A total volume of 100 to 150 gallons of water will be collected by this method.

Procedures that will be used in the actual treatability tests are presented in the LOP.



## 4.0 DOCUMENTATION AND FIELD OBSERVATIONS

### 4.1 LABELING

All samples will be labeled in the field using a standardized numbering and coding system. The samples will then be tagged with EPA sample tags and sealed with custody tape (Figure 4-1) and logged on chain-of-custody forms (Figure 4-2). Special Analytical Services (SAS) forms (Figure 4-3), Sample ID matrix (SIM) forms (Figure 4-4) and Organic Traffic Reports (OTRS) (Figure 4-5) will be maintained (see NETSOP-12, Appendix A).

#### 4.1.1 Initial Labeling

All sample containers will be labeled with an indelible pen prior to being filled with water at the sampling site. The sample label will show the date, time of sampling (military time), sampler's initials, sample site number, EPA tag number, type of analysis, and preservative, if applicable.


#### 4.1.2 Sample Numbering System

A sample numbering system will be used to identify each sample site. This system will provide a tracking number to allow retrieval and cross-referencing of sample information. A listing of sample identification numbers with written descriptions of sample location, type, dates sampled, etc., will be maintained. Each sample number will be composed of the following components:

Project Identifier -- A three-letter designation will be used to identify the site where the sample is collected. For this project, it will be WSP (Warm Springs Ponds).

Sample Type -- Each sample type collected during the sampling program will be identified by a two-letter alpha code:

- GW - ground water sample
- SS - surface water sample
- PS - point source water sample
- SD - sediment sample

 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY OFFICIAL SAMPLE SEAL		SAMPLE NO. 8-60131		DATE 7/25/87
		SIGNATURE John Doe		
PRINT NAME AND TITLE (Inspector, Analyst or Technician)				
SEAL BROKEN BY				
DATE				

EPA FORM 7500-2 (R7-75)

Project Code WSP	Station No. SS-22	Month/Day/Year JULY 25 1987	Time 1300	Designate: Comp. <input checked="" type="checkbox"/> Grab <input type="checkbox"/>	Preservative: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> <i>Appropriate box</i>	
					ANALYSES	
Station Location <b>WEST DECANT TOWER</b> Samplers (Signatures) <i>John Doe</i>					BOD	Anions
					Solids	(TSS) (TDS) (SS)
					COD, TOC, Nutrients	
					Phenolics	
					Mercury	
					Metals	
					Cyanide	
					Oil and Grease	
					Organics GC/MS	
					Priority Pollutants	
					Volatile Organics	
					Pesticides	
					Mutagenicity	
					Bacteriology	
					Remarks: SAS 1 TOTAL METALS w/HNO <sub>3</sub>	
Tag No. 8-60131			Lab Sample No.			

FIGURE 4-1

EPA SAMPLE TAG AND CUSTODY TAPE  
 FOP  
 WARM SPRINGS TREATMENT PONDS INVESTIGATIONS  
 AUGUST 1987

PROJECT NAME

**Split Samples.** ☐ Accepted ☐ Declined ☐ Signature

**Distribution: Original Accompanies Shipment: First Copy to Coordinator Field Files: Second Copy to Representative of Inspected Facility**

R8 EPA-014B (4-21-86)

Signature \_\_\_\_\_

31675

CHAIN-OF-CUSTODY FORM  
FOP

WARM SPRINGS TREATMENT PONDS INVESTIGATIONS  
AUGUST 1987



SPECIAL ANALYTICAL SERVICE  
PACKING LIST

Sampling Office: <u>NET</u>	Sampling Date(s): <u>JULY 25, 1987</u>	Ship To:     Attn:	For Lab Use Only  Date Samples Rec'd: <hr/> Received By: <hr/>
Sampling Contact: <u>JOHN DOE</u> (name)	Date Shipped: <hr/>		
<u>800-622-7960</u> (phone)	Site Name/Code: <u>WSP</u>		

Sample Numbers	Sample Description i.e., Analysis, Matrix, Concentration	Sample Condition on Receipt at Lab
1. <u>8-60131</u>	<u>SAS 1 - H<sub>2</sub>O - LOW</u>	
2. <u>8-60132</u>	<u>SAS-4 - H<sub>2</sub>O - MEDIUM</u>	
3. <u>8-60133</u>	<u>SAS-5 - H<sub>2</sub>O - LOW</u>	
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20. <u>8-60150</u>	<u>SAS-5 - H<sub>2</sub>O - LOW</u>	


White - Sample office    Yellow - Lab Copy    Pink - Return to sample office upon receipt

FIGURE 4-3

SPECIAL ANALYTICAL SERVICE FORM  
FOP  
WARM SPRINGS TREATMENT PONDS INVESTIGATIONS  
AUGUST 1987





	U.S. ENVIRONMENTAL PROTECTION AGENCY HWI Sample Management Office P.O. Box 918 Alexandria, Virginia 22304-918 • Tel: 557-2491 • Fax: 557-2491	Sample Number
ORGANICS TRAFFIC REPORT		

① Case Number: <u>5854</u>  Sample Site Name/Code: <u>WSP</u> <hr/> <hr/>	② SAMPLE CONCENTRATION (Check One)  <input checked="" type="checkbox"/> Low Concentration <input type="checkbox"/> Medium Concentration  ③ SAMPLE MATRIX (Check One)  <input checked="" type="checkbox"/> Water <input type="checkbox"/> Soil/Sediment	④ Ship To: <u>ANAL. LAB</u> <u>100 MAIN ST.</u> <u>ANYTOWN, MA 12345</u> <u>Attn: GC MASSPEC</u> <hr/> Transfer Ship To:																								
⑤ Regional Office: <u>2</u> Sampling Personnel: <u>JOHN DOE</u> (Name) <u>800-622-7960</u> (Phone) Sampling Date: <u>JULY 25 1987</u> <u>SAME</u> (Begin) (End)	⑥ For each sample collected specify number of containers used and mark volume level on each bottle.  <table border="1" style="width: 100%; border-collapse: collapse; font-size: small;"> <thead> <tr> <th></th> <th style="text-align: center;">Number of Containers</th> <th style="text-align: center;">Approximate Total Volume</th> </tr> </thead> <tbody> <tr> <td>Water (Extractable)</td> <td style="text-align: center;">4</td> <td style="text-align: center;">4 LITER</td> </tr> <tr> <td>Water (VOA)</td> <td style="text-align: center;">2</td> <td style="text-align: center;">80 ML</td> </tr> <tr> <td>Soil/Sediment</td> <td></td> <td></td> </tr> <tr> <td>Water (Ext/VOA)</td> <td></td> <td></td> </tr> <tr> <td>Other</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Number of Containers	Approximate Total Volume	Water (Extractable)	4	4 LITER	Water (VOA)	2	80 ML	Soil/Sediment			Water (Ext/VOA)			Other								
	Number of Containers	Approximate Total Volume																								
Water (Extractable)	4	4 LITER																								
Water (VOA)	2	80 ML																								
Soil/Sediment																										
Water (Ext/VOA)																										
Other																										
⑦ Shipping Information  <u>FEDERAL EXPRESS</u> Name of Carrier <u>07/28/87</u> Date Shipped: <u>123579012</u> Airbill Number:																										
⑧ Sample Description  <input checked="" type="checkbox"/> Surface Water <input type="checkbox"/> Mixed Media <input type="checkbox"/> Ground Water <input type="checkbox"/> Solids <input type="checkbox"/> Leachate <input type="checkbox"/> Other (specify) _____	⑨ Sample Location  <u>SS-22</u> <u>WEST DECANT TOWER</u>																									
⑩ Special Handling Instructions: (e.g., safety precautions, hazardous nature) <div style="text-align: center; font-weight: bold; font-size: large;">                     EPA PRIORITY POLLUT LIST                 </div> <div style="text-align: center; font-size: small; margin-top: 20px;">                     SMO COPY                 </div>																										

FIGURE 4-5

ORGANIC TRAFFIC REPORT  
 FOP  
 WARM SPRINGS TREATMENT PONDS INVESTIGATIONS  
 AUGUST 1987

Serial Number -- The third component of the sample number will be a 2-digit serial number. The serial number will be used to identify locations from descriptions written in the field log book.

Examples of the numbering system to be used for natural and CC samples are:

Natural Sample WSP-SS-38

Where:

WSP - Warm Springs Pond

SS - Surface water sample

19 - Station number

#### 4.2 SAMPLE CONTROL

EPA serialized sample tags will be used to label each sample for analysis. Chain-of-custody records will be completed for all samples according to EPA requirements and will accompany sample shipment. Completed custody seals will be placed on all sample containers and ice chests containing samples. Airbills will be used to ship samples to the analytical laboratory.

#### 4.3 FIELD NOTEBOOKS

Field forms will be used for recording the data-collecting activities performed at a site (see NETSOP-10, Appendix A). The forms will be numbered consecutively. Field forms will be assigned by the Document Control Officer to field crew leaders and/or to the person in charge of sampling. Field forms will remain in that person's custody during the sampling activity.

Entries on field forms will include sufficient detail to reconstruct site activities without reliance on memory. At the beginning of each entry, the date, start time, weather, field personnel present, level of personal protection, and the name of the person making the entry will be recorded. The names of visitors and the purpose of their visit also will be recorded in the site team leader's field form. Any deviation from SOPs will also be noted.



All measurements and samples collected will be recorded. All entries will be in ink, weather permitting, with no erasures. If an incorrect entry is made, the information will be crossed out with a single strike mark and initialed and dated. Whenever a sample is collected or a measurement made, a detailed description of the station location, sample identification, and type of sample will be recorded. The film roll number and number of photographs taken of the station will also be noted, where applicable. All equipment used to make measurements will be identified, including the most recent calibration date.

Samples will be collected following the SCPs documented in this plan. The equipment used to collect samples will be noted, along with the sampling time, sample description, and number of containers. In addition, the number of the ice chest into which the sample is placed in the field will be recorded. Sample numbers will be assigned prior to going onsite.



## 5.0 PROJECT PERSONNEL

Field personnel and associated responsibilities proposed for the project include the following:

Field Crew Supervisor: M. Grotbo

Field Crew Leader: J. Franklin, M. Grotbo

Document Control Officer: S. Staley

Safety Officers: J. Franklin, D. Hazen

Assistant Safety Officer: S. Staley

Hydrologists: P. Dunlavy, D. Hazen, R. Braun, W. Bucher, T. Grotbo,  
M. Stahly, J. Bowser, D. Stiller, S. Mitchell, D. Bunte

Functions of the individuals or entities presented above are as follows:

Field Crew Supervisor -- responsible for all phases of field data collection including equipment and materials procurement, sampling logistics, packaging and custody, and data compilation and presentation.

Field Crew Leader -- responsible for field data collection at the crew level. Includes supervision of assigned crews to collect viable, defensible data in accordance with the project FCP and CAPP.

Document Control Officer -- responsibilities are to: (1) ensure data and documents are released and distributed in accordance with EPA requirements, (2) ensure data and documents are kept secure, under custody when necessary, without unauthorized reproduction and/or alteration, and (3) ensure document or data holders are known.

Safety Officer(s) -- responsibilities include those associated with implementing and enforcing the project safety plan. Includes conducting briefings for field crews as necessary, providing appropriate and adequate safety equipment for all field crews, and supervising adherence to the plan.

## 6.0 SAMPLE CONTAINERS, PRESERVATION, AND SHIPPING

### 6.1 SAMPLE CONTAINERS

Sample containers used under this FCP will be one-liter narrow-mouthed polyethylene I-CHEM bottles, sediment sampling tubes, 8 oz glass I-CHEM bottles, one-liter amber glass bottles, VOA vials, 120 mL glass vials, and nalgene carboys.

### 6.2 PRESERVATION

Surface water samples will receive chemical preservation as indicated in Table 6-1 for each separate portion of the sample. The dissolved metals portion of each sample will be filtered in the field through a 0.45-micron filter and then preserved with  $\text{HNO}_3$  to a pH of less than 2 (see NETSOP-04). Samples collected for acid soluble metals will be preserved and prepared according to procedures detailed in NETSOP-19 (Appendix A) prior to shipment. Samples collected for arsenic speciation will be sampled and preserved in accordance with NETSOP-38 (Appendix A).

### 6.3 SHIPPING

All collected water samples will be packed in ice chests and shipped in accordance with NETSOP-09 (Appendix A). Non-combustible, absorbent material will be used for packing in the ice chests. At least two large containers of recently frozen "blue ice" will accompany all water samples in each cooler.

All ice chests with samples will be shipped to the analytical laboratory via Federal Express Priority 1, next day delivery.

TABLE 6-1  
BOTTLES, PRESERVATIONS, AND SHIPPING REQUIREMENTS

<u>Sample Type</u>	<u>Assumed Concentration</u>	<u>Type [a] Analysis</u>	<u>Container Filling</u>	<u>Preservation</u>	<u>Shipping</u>
Water samples for total metals and acid soluble metals	Low to Medium	1	Two 1-liter polyethylene bottle/ fill to shoulder of bottle	HNO <sub>3</sub> to pH <2 [b]	Federal Express Priority 1
Water samples for dissolved metals	Low to Medium	2	One 1-liter polyethylene bottle/ fill at least one-quarter full with filtered (0.45u) water	HNO <sub>3</sub> to pH <2 Iced to 4°C	Federal Express Priority 1
Water samples for other analyses	Medium	3	One 1-liter polyethylene bottle/ fill to shoulder of bottle	Iced to 4°C	Federal Express Priority 1
Water samples for nitrate plus nitrite	Medium	4	One 1-liter polyethylene bottle/ fill to shoulder of bottle	H <sub>2</sub> SO <sub>4</sub> to pH <2 Iced to 4°C	Federal Express Priority 1
Water samples for priority pollutants	Low	5	Four 1-liter amber glass/filled Two VOA vials	Iced to 4°C	Federal Express Priority 1
Sediment samples from pond bottoms with overlying water	Medium	6	Sediment sample tube filled	Iced to 4°C	Federal Express Priority 1
Sediment samples from pond bottom with overlying water	Low	7	One 8 oz. wide-mouthed glass/filled Two 120 mL wide-mouth glass vials	Iced to 4°C	Federal Express Priority 1
Sediment samples from flocculated zone in ponds	Medium	8	One 8 oz. wide-mouth glass/filled	Iced to 4°C	Federal Express Priority 1
Sediment/soils from Mill-Willow Bypass area	Medium	9	One 8 oz. wide-mouth glass/filled	Iced to 4°C	Federal Express Priority 1
Water samples from arsenic speciation	Low	10	One 1-liter polyethylene bottle/ fill at least one-quarter full with filtered (0.45u) water	HCl; 1 ml for 100 ml of sample Iced to 4°C	Federal Express Priority 1

[a] Type of Analysis: 1 = Total and acid soluble Cu, Fe, Zn, Pb, As, Cd, Mn, Al  
2 = Dissolved Cu, Fe, Zn, Pb, As, Cd, Mn, Al, Ca, Mg, Na, K  
3 = Total suspended solids, hardness, alkalinity (as HCO<sub>3</sub>/CO<sub>3</sub>), sulfate, chloride, phytoplankton, chlorophyll "a", total phosphorous, ortho-phosphate  
4 = Nitrate plus nitrite  
5 = Priority pollutants described in project LAP  
6 = Total Cu, Fe, Zn, Cd, As, Pb, Mn, Al, Se, Hg, Cr, sulfide, percent solids, particle size distribution, total CH, EP toxicity for metals  
7 = Priority pollutants described in project LAP  
8 = Same as No. 6  
9 = Same as No. 6, and water soluble Cu, Zn, Cd, Mn, As, Al; pH, SC  
10 = As (III) and As (V)

[b] Further preservation required for acid soluble metals samples in accordance with NETSOP-19 (Appendix A).

## 7.0 HEALTH AND SAFETY

All personnel involved with field work during the study will be required to adhere to the project Health and Safety Plan. The project safety officer will always accompany field crews entering the site. All field personnel will have had current training in CPR and general first aid and will have at least 40 hours of EPA-approved advanced training in health and safety considerations at hazard waste sites.

Radio communication will be available in all field vehicles used during the investigation. Portable two-way radios will also be used for direct communication between crews.

Any and all safety-related incidents will be reported immediately to the project safety officer, who in turn will file appropriate documentation (as described in the Health and Safety Plan) with the project RSPO. Emergency contact numbers will be those identified in the project Health and Safety Plan.



## 8.0 REFERENCES CITED

- CH2M HILL, 1987a. Draft Silver Bow Creek Selected Data Gaps Study Plan. Prepared for Montana Department of Health and Environmental Sciences. May, 1987.
- CH2M HILL, 1987b. Quality Assurance Project Plan for the Warm Springs Treatment Ponds Investigations. Prepared for Montana Department of Health and Environmental Sciences. August, 1987.
- CH2M HILL, 1987c. Laboratory Analytical Protocol; Warm Springs Treatment Ponds Investigations. Prepared for Montana Department of Health and Environmental Sciences. August, 1987.
- MultiTech, 1987. Silver Bow Creek Remedial Investigation. Submitted to Montana Department of Health and Environmental Sciences.



APPENDIX A  
STANDARD OPERATING PROCEDURES





NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
STREAMFLOW MEASUREMENT; WADING TECHNIQUE

1. Visually check wading rod, current meter (pygmy or AA types), and headsets for damage. Repair damage to equipment and replace batteries in headsets as necessary.
2. Evaluate reach of stream to determine type of meter necessary to make flow measurement. For shallow, low velocity streams, use a pygmy-type current meter; for relatively deep, higher velocity streams, use a standard AA-type meter.
3. Perform spin test on selected meter; the cups on the pygmy meter should spin continuously for at least 30 seconds; on the AA meter, the cups should spin for at least two minutes. If the current meter fails the spin test, lubricate and adjust as necessary to achieve desired results.
4. Attach current meter and head set to wading rod. Check the electric connection between the current meter and headset by spinning cups on the current meter and listening for clicks in the head phone. Adjust equipment as necessary such that a clear click is heard upon every revolution of the cups.
5. Anchor surveyor's tape tautly across the stream perpendicular to the direction of streamflow and attach on either side of the stream. Provide at least one foot of clearance between the water surface and surveyor's tape.
6. Divide the cross-section of the stream into 20 to 30 partial sections based on values noted on the surveyor's tape denoting edge of water on each side of the stream. Concentrate partial flow measurement sections in areas of the stream cross-section containing the majority of flow.
7. Person wading in stream calls out to data recorder on shore the location of the first measuring point with respect to the surveyor's tape. Person in stream measures water depth at that vertical, using wading rod, to the nearest one-hundredth of a foot, if possible.
8. Data recorder calls out height(s) above the streambed at which velocity measurements are to be made. If the water is more than 2.5 feet deep, measurements should be made at 20 and 80 percent of the water column height. For water columns less than 2.5 feet deep, a single measurement of velocity at 40 percent of the water column height will suffice. Person wading adjusts height of current meter on the wading rod accordingly.

9. Person wading stands downstream of the surveyor's tape, facing upstream, holding the wading rod vertical in the water with the current meter facing directly into the current. Person should not stand directly behind the meter but either to the left or right so as not to influence velocity readings.
10. Person wading counts clicks at each vertical for a minimum of 40 seconds and calls final tally of both number of clicks and time to data recorder. Click count should correlate with velocity chart provided with each meter.
11. Repeat procedure at each vertical.
12. Data recorder reduces data on-site and records other appropriate information on the field form.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
SURFACE WATER SAMPLING

1. Visually check DH-48 or D-74 sediment sampler for damage. Replace or repair parts as necessary.
2. Decontaminate all parts of sediment sampler utilized including nozzle, body, gasket, sample bottle, and handle using the procedure outlined in NETSOP-011.
3. Following streamflow measurement, and utilizing the same tag line or surveyor's tape stretched across the stream, divide the stream into four or more sections of equal discharge based on stream gaging results. At the mid point of each equi-discharge section, lower the sediment sampler into the stream with one continuous motion making sure the sample handle is vertical. Lower the sediment sampler to the streambed at a rate based on the rating curve for the nozzle size used and the velocity of the stream. The sample bottle should be just under half full upon encountering the streambed. Raise the sampler at a rate similar to the descent rate. The sample bottle should not be completely full upon removal from the stream. Pour contents of sediment sample bottle into a churn splitter.
4. Repeat procedure for the other equal discharge sections identified, composite collected samples into the churn splitter.
5. Mix composite sample in the churn splitter and fill total metals and acid soluble metals first.
6. Fill out appropriate field form documenting sample location, time, and other pertinent information prior to leaving sampling site.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD SAMPLE FILTRATION

1. Filtration apparatus will be decontaminated in accordance with NETSOP-011.
2. Visually inspect filtration equipment for damage. Replace parts or repair equipment as necessary.
3. Place 10-15 milliliters of 10% dilute nitric acid into filter apparatus containing 0.45 micron filter. Apply vacuum, discard filtered solution.
4. Repeat above procedure three times using sample water. Discard filtrate. If unable to repeat three times, use a pre-filter before using the .45 micron filter.
5. Fill filter with sample and apply vacuum. Use small quantities of filtered water to rinse sample container three times.
6. Fill sample container to appropriate level with filtered sample and mark level with permanent marker. Add appropriate preservative, if necessary. Invert sample container several times to insure complete sample - preservative mixing.
7. Place sample container into cooler; package and ship in accordance with NETSOP-009.
8. If extremely turbid sample water is obtained, use same procedure utilizing pre-filter (usually 3.0 micron) followed by 0.45 micron filtration.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

Field Procedure

1. Check red line and zero point on meter. Adjust as necessary.
2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.
3. Place water sample in decontaminated glass beaker.
4. Rinse probe with DI water and place conductivity probe in sample water.
5. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. Turn instrument on to appropriate scale for sample analyzed. Multiply reading by the correct multiplier from the dial and record to the nearest ten micromhos/centimeter. Measure sample temperature to nearest 0.5°C from conductivity meter. Record temperature.
6. Remove probe from sample and rinse probe with DI water.

Instrument Calibration

At the beginning and end of each day of sampling, determine cell constant in the field.

1. Rinse probe with deionized water.
2. Measure conductivity of two KCl solution standards which bracket expected sample values.
3. Measure temperature of both KCl solution standards.
4. Calculate cell constant for each standard and average the two values. The cell constant is the ratio of the computed conductivity to the measured conductivity of the standard KCl solution. Use this averaged constant and measured field temperatures and conductivities to calculate conductivity at 25°C for each sample taken during the day.

Maintenance

1. Store meter in its case during transport. If stored for long periods of time, immerse probe in distilled water.
2. Check batteries before taking meter into the field. Carry spare batteries and screwdriver.

3. Inspect conductivity electrodes on a monthly basis for cracks or other damage.
4. If platinum black has flaked off, a sharp end point cannot be achieved or readings are erratic. Return probe to factory so it can be replatinized.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF pH

Field Procedures

1. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.
2. Rinse pH electrode with deionized water.
3. Check meter using standard that is nearest the expected pH. If not within 0.1 pH units re-calibrate meter using appropriate standards.
4. Fill beaker with sample water.
5. Immerse electrode in sample while swirling the sample to provide thorough mixing. Turn on meter. Electrode filler level should be 1/2-in. above sampling surface level. Read pH to nearest 0.1 unit once the reading is stabilized.
6. Record sample pH. Note any problems such as erratic readings.
7. Rinse probe with DI water and store according to manufacturer's directions.

Instrument Calibration

1. Calibrate pH meter in the field at the beginning of each day of field work when pH will be measured, or when the standard check is out of acceptable bounds. Calibrate using following procedure:
  - o Rinse pH electrode with distilled water.
  - o Immerse electrode in beaker of commercial calibration solution of pH at or below that expected for the samples.
  - o Calibrate meter to appropriate pH.
  - o Remove electrode from solution, rinse with distilled water, air dry.
  - o Immerse electrode in second calibration solution having a pH 2 to 3 units higher or lower than the first, calibrate meter to solution.
  - o Measure pH of one of the calibration solutions. If measured value differs from expected value by more than 0.1 units, obtain fresh calibration solutions and recalculate. If discrepancy persists, begin trouble-shooting procedures following meter operating instructions: check batteries, connections, etc. If meter checks out, inspect combination electrode. Clean and refill as necessary.

## Maintenance

1. Store meter in its case with electrode immersed in a pH 7 buffer solution.
2. Inspect electrode weekly.
  - o Plug of filler hole should be firmly seated when meter is stored for a week or more.
  - o Check glass electrode for cracks or scratches.
3. Check batteries each time meter is used. Carry a spare battery pack and a screwdriver into the field in the pH meter case.
4. Check pH meter monthly with a pH meter tester and adjust as necessary.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF WATER TEMPERATURE

1. Carry two NBS - calibrated thermometers inside cases, into the field.
2. Check thermometer for cracks or gaps in the mercury. Do not use thermometers if either cracks or gaps are visible.
3. When possible, measure temperature of surface water at midstream submersing the thermometer for approximately one minute or until temperature stabilizes.
4. When in situ temperature measurements are not possible, draw sample of at least 200 mL into a decontaminated beaker or sample bottle as soon after sampling as possible.
5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about 1 minute).
6. Record temperature to nearest  $0.5^{\circ}\text{C}$  in field log book or on field data sheet.
7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within  $0.5^{\circ}\text{C}$ .

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen (DO) meter for damage - repair as necessary.
2. Rinse probe and cable with DI water.
3. Prepare probe and DO meter in accordance with instrument manufacturer's operating procedures. Make certain probe contains sufficient electrolyte and the oxygen sensor membrane is in good repair.
4. Calibrate probe and meter using the fresh water - air calibration method. Correct calibration value of temperature and altitude; adjust meter accordingly.
5. When possible place probe directly into the stream if not, place probe into beaker filled with sample. Manually raise and lower probe through sample about 1 ft./sec. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen concentration.
6. Read dissolved oxygen value. Record appropriate data on field forms.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
SAMPLE PACKAGING AND SHIPPING

All surface water samples collected should be packaged and/or shipped utilizing the following procedures.

Packaging

1. Place labelled sample bottles in a zip lock bags and then in a high quality cooler containing two large containers of recently frozen blue ice, making sure the plug is taped shut both inside and outside.
2. Position the sample bottles upright and surround the samples with noncombustible, absorbent, cushioning material for stability during transport.
3. Place the laboratory/sampling paperwork in a ziplock bag and tape it to the inside lid of the shipping container (see Shipping Papers).
4. Close and seal the cooler with at least two signed and dated custody seals and sealer tape. Tape cooler shut utilizing fiberglass tape.
5. Secure Air Bill to cooler and ship via express air service.
6. Notify project manager of shipment.

Marking/Labeling

7. Use abbreviations only where specified.
8. Place the following information either hand printed or in label form, on the outside container:
  - o Laboratory name and address (on Air Bill)
  - o Return cooler to: (name and address)
9. Secure "This End Up" and "Fragile" stickers clearly on top of the shipping container. Put upward pointing arrows on all four sides of the container. No other marking or labeling is required.

Shipping Papers

10. No DOT shipping papers are required. All field samples, (natural and QC), will be documented with the following forms. These forms will be placed in ziplock bags and taped to the inside lid of the same cooler as the samples to which they pertain.
  - o Chain-of-custody form
  - o Special Analytical Service
  - o Sample matrix form

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD FORMS

All pertinent field survey and sampling effort information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information so that someone can reconstruct all field activity without relying on the memory of the field crew. All entries shall be made in indelible ink weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author. All corrections shall consist of line-out deletions which are initialed.

At a minimum, entries on the field sheet shall include:

- o Date and time of starting work and weather conditions.
- o Names of field crew leader and team members
- o Project name or type
- o Description of site conditions and any unusual circumstances.
- o Location of sample site, including map reference, if relevant
- o Equipment ID numbers
- o Details of actual work effort, particularly any deviations from the field operations plan or standard operating procedures
- o Field observations
- o Any field measurements made (e.g., pH)

For sampling efforts, specific details for each sample should be recorded. In addition to the items listed above, the following general information should be included on the field form during sampling efforts:

- o Type and number of samples collected
- o Sampling method, particularly deviations from the operating procedures

Strict custody procedures shall be maintained with the field forms utilized. While being used in the field, field forms shall remain with the field team at all times. Upon completion of the field effort, field forms shall be filed in an appropriately secure manner in Northern's Helena office. Photocopies of the original field forms will be used as working documents.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable.

Field personnel must wear disposable examination gloves while decontaminating equipment at the project site. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to ensure thorough decontamination:

1. Set up the decontamination zone approximately 15 feet upwind from the sampling area. This area will be designated by the field crew leader.
2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.
3. The general decontamination sequence for field equipment includes: wash with Liquinox or its equivalent; DI water rinse; dilute nitric acid rinse; DI water rinse; rinse with sample water three times.
4. Rinse equipment with hexane solution if sampling for organic contamination. Follow with a DI water rinse.

All disposable items (e.g., paper towels, examination gloves, wash cloths) should be deposited into a garbage bag and disposed of in an approved landfill. Contaminated wash water does not have to be collected.

If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

2-gallon plastic tubs
2-gallon pressurized garden sprayer
5-gallon plastic water-container
Liquinox (soap)
Hard bristle brushes
Garbage bags
Latex gloves
Squeeze bottles
5-gallon carboy DI water
1-gallon cube of 10% HNO <sub>3</sub>
Paper towels

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
SAMPLE DOCUMENTATION

The purpose in filling out field documents is to provide enough information to reconstruct the sampling event without relying on the memories of the field crew. It is the responsibility of the DCO to assure field documents contain sufficient detail, and are correct. All entries will be made in indelible ink weather conditions permitting and all corrections will consist of initialed line-out deletions.

Complete and accurate sample documentation is essential for Level B criteria. The responsibility of the document control officer will be to meet the Level B goal.

Documents to be completed for each sample generated during the Screening study are:

- o Northern Engineering and Testing's Field Form .
- o Chain-of-Custody Form
- o EPA Sample Tags
- o Custody Seal
- o SAS Packing Lists
- o Sample Identification Matrix Forms
- o Organic Traffic Report (if applicable)

Responsibility for the completion of these forms will be with each field crew leader.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
QC SAMPLES

QC samples do not have any unique identifying codes that would enable the contract lab or others to bias these samples in any way. There are, however, differences in blank and standard samples which might separate them from the rest of the sample train. The sampling team will strive for uniformity in sampling technique to limit sampling error. The QC samples will be identified only on the SAMPLE IDENTIFICATION MATRIX. The codes on the matrix sheet are as follows.

N - Natural Sample  
R - Replicate - Duplicate Sample  
BB - Bottle Blank  
WB - Cross Contamination Blank  
BFS- Blind Field Standard  
S - Split Sample  
KB - Kimwipe Blank  
TB - Travel Blank

In general, QC samples will be inserted into the sample train on a one in ten basis or one per day per sampling crew, whichever results in more QA/QC samples (one in twenty for soils or sediment sampled).

1. A duplicate sample will be a second sample taken at a site.
2. A bottle blank will be deionized water placed directly into the sample bottles.
3. A cross contamination blank will be deionized water run through all sampling equipment or a Kimwipe wiped over decontaminated equipment and then placed into sample bottles.
4. A field standard will be an EPA approved standard prepared in the laboratory and entered into the sample train.
5. A split sample will be obtained for shipment to a separate laboratory for analysis. These samples are collected typically on a one in five basis.
6. A Kimwipe blank will be a Kimwipe obtained directly from its packaging and inserted into a sample container.
7. A travel blank will be a deionized water sample prepared at the analytical laboratory and shipped to the sampling team; the blank must travel in a cooler with the sampling team.

Each field crew leader will be responsible for all QC samples prepared by that crew.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
MONITORING WELL CONSTRUCTION

1. Arrive on-site with properly sized drilling equipment and materials for site conditions. All drilling equipment and materials should be properly decontaminated prior to its arrival on-site. Decontamination usually includes steam - or hot water-cleaning methods.
2. Drilling muds or drilling solutions of any kind are not to be used during drilling activities in conjunction with monitoring well construction. Acceptable drilling techniques include air-rotary, mud-rotary (using clean water only), cable tool, or hollow-stem auger. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. It is suggested threaded steel casing be used in lieu of welding joints together to minimize this source of potential well contamination. Hydraulic jacks or the drill rig can be used to pull back the steel casing following emplacement of plastic casing.
3. A detailed lithologic log should be completed during drilling activities. Water bearing characteristics of the formations should also be denoted on the log. In addition, details of monitoring well construction should also be described on the well log including total depth, perforated interval, sizes and types of construction materials, etc.
4. Either a single - or multi-completion monitoring well can be constructed in a single borehole. Backfill chemically-inert silica sand to above the perforated interval and emplace a bentonite plug above the sand following installation of factory-screened and blank PVC (stainless steel or PTFE for organics) well casing into the borehole. Begin pulling steel casing out of borehole. Emplace silica frac sand about any other perforated sections in the borehole; install bentonite plugs above and below perforated sections. Backfill remaining well annulus with a bentonite slurry or with grout to the surface.
5. Place locking well protector over PVC casing(s) after outer steel casing has been removed from the borehole. Place bentonite plug below bottom of well protector; grout well protector in place and lock with high quality lock.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
MONITORING WELL DEVELOPMENT

1. Visually inspect all well development equipment for damage - repair as necessary.
2. Decontaminate all stingers, air hoses, surge blocks, etc. by scrubbing with brush and liquinox solution, rinsing with dilute nitric acid solution, and rinsing with deionized water.
3. If using compressed air method for well development, make certain compressor utilized does not produce air laden with hydraulic fluid for lubricating purposes. This may affect the integrity of the monitoring well for producing viable water quality data.
4. Develop well by using surging techniques (surge block or bailer) followed by well evacuation. Repeat this procedure until evacuated water is visibly clean and essentially sand-free.
5. Report field observations on standard form.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
GROUND WATER SAMPLING

1. Inspect all sampling equipment for damage upon arriving on-site. Repair equipment as necessary.
2. Decontaminate sampling equipment by scrubbing with brush and liquinox, solution, rinsing with dilute nitric acid, and rinsing with deionized water.
3. Sampling domestic wells:
  - a. Turn-on household fixture (preferably outside faucet) and allow well to discharge for several minutes. Be certain discharge point is on the well-side of any water conditioning device.
  - b. Monitor field parameters periodically during discharge period. When field parameters are within plus or minus five percent over three consecutive readings, the well is ready for sampling.
  - c. Fill sample containers and add sample preservatives as appropriate. Do not collect samples through rubber hoses. Samples should be collected directly from hydrant or faucet. Perform field parameter tests.
  - d. Complete field forms in accordance with NETSOP-10.
4. Sampling monitoring wells:
  - a. Evacuate monitoring wells with bailer or pump; monitor field parameters for consistency during evacuation process. Remove a minimum of three bore volumes of water from the monitoring well.
  - b. Following well evacuation, install decontaminated bladder pump into or above perforated zone in well; commence pumping and monitor field parameters for consistency using field parameter box. Well is ready for sampling when field parameters are within plus or minus five percent on three consecutive readings.
  - c. Field filter sample water in accordance with NETSOP-04 if appropriate. Add sample preservatives as appropriate; fill out field forms in accordance with NETSOP-10.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
PREPARATION AND PRESERVATION OF ACID SOLUBLE SAMPLES

1. Allow samples arriving from field to adjust to room temperature.
2. Obtain initial pH measurement of sample in accordance with NETSOP-06.
3. Adjust pH of sample by adding drops of  $\text{HNO}_3$  or  $\text{NaOH}$  as necessary to attain a pH reading of  $1.75 \pm 0.1$ . This adjustment of sample pH must be completed within 3 days of sample collection time.
4. Cap sample bottles and allow samples to remain idle for at least 16 hours.
5. Filter sample through decontaminated filtration apparatus containing 0.45 u filter. Pour filtered sample back into original sample bottle.
6. Place bottles in cooler and prepare for sample shipment to laboratory.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Check well probe prior to leaving for field for defects. Repair as necessary. Make certain the well probe, a decimal tape measure and extra batteries are in the carrying case.
2. Measure all wells (monitoring and domestic) from the top of the well casing on the north side or from a designated measuring point, as appropriate.
3. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.
4. Decontaminate well probe between each measurement by rinsing with deionized water.
5. Calibrate well probe to a steel tape prior to and following each data gathering episode. Note any corrections to well probe measurements on field forms. Adjust reported data as necessary.



**NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
SOIL SAMPLE COLLECTION AND HORIZON DESCRIPTION**

Soil samples will be collected from the face of hand-dug soil excavations six inches deep or from the upper two inches of the soil profile, depending upon project objectives. Samples from deeper in the profile where thought necessary will be obtained with a bucket auger. Each sample collected will be deposited directly into a plastic tub by scraping with a plastic trowel or dumping from the bucket auger. The sample will then be mixed and any clods will be broken up.

Samples will be split by mixing and dividing on a canvas sheet or by use of a mechanical sample splitter. A subsample will be set aside for XRF determination, if necessary. Sample splits for use as a replicate will also be obtained as described above. A small amount of soil will be placed into two styrofoam cups for pH, Eh and SC determination, if applicable (see NETSOP-36). The sample will then be transferred to an 8-ounce ICHEM jar.

Between sample collection, all equipment will be cleaned thoroughly with a stiff brush and rinsed with distilled water and paper towels. A wipe test (kimwipes) will be performed after decontamination as a cross-contamination blank once at each site. A bottle blank, unused kimwipes, will also be inserted into the sample train at each site.

Soil horizons have the following morphological features described using standard SCS-USDA methods (Soil Survey Staff, 1975). Results will be numerically encoded onto standard forms.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
X-RAY FLUORESCENCE SPECTROMETER (XRF) USE AND CALIBRATION

The chemical characterization of soil samples in the field will be determined by the field portable X-ray fluorescence (SRF) Spectrometer ATX-100 instrument manufactured by Aurora Tech, Inc, 331 Rio Grande Street, Salt Lake City, Utah. The instrument uses low level self-contained and shielded radioactive sources that produce spectral peaks whose position (energy level) is specific to an individual element and whose peak height or area which is indicative of the concentration of that element within the area exposed to the source. Two sources are proposed to be used, cadmium-109 (15 millicuries) and Iron-ss (100 millicuries) implaced by the manufacturer. These sources will allow semiquantitative determination of the copper, zinc, arsenic, cadmium, iron, manganese and lead concentrations. Additional elements that will be monitored include chromium, barium, cobalt, nickel, selenium, and molybdenum.

The detection limit for each parameter is a function of source strength, geometry/particle size, counting time, and the concentration of other elements. Since the source strength and instrument geometry are constants, the detection limit is dependent on geometry/particle size, counting time, and concentration. It has been demonstrated that 80 mesh particle size dominantly composed of a siliceous or calcareous skeletal matrix will give analytical results within 20 percent. The larger the particle size, the larger the error. A rock made up of fine-grained minerals, however, will essentially have the same precision and accuracy as a finely ground sample.

The counting time also affects the detection limit. In general, the longer the counting time, the lower the detection limit, and certainly the higher the precision and accuracy. The instrument has controllable time units of 10, 30, 100, 300, and manual control seconds. The 30 second counting time will likely be the standard for this test. This rate may change for either or both sources depending on the actual sample matrix encountered in the field.

Experience with similar instruments with poorer resolution indicate that the semiquantitative detection limit can be expected to be below 10 parts per million on the five elements of primary concern. One to two parts per million is achievable but not with high precision.

The primary operator will receive one day's training on the proper use of the instrument particularly for health and safety purposes. The manufacturer's statement on radiation safety is also attached. Each operator will have a gamma film badge service (monthly) and will have the dates and times used logged in the record book specifically kept for this purpose.

Calibration of the unit will be provided by two methods.

A field calibration based on internal factory standards will be used for developing a working field "screening" calibration used for contaminant assessment. Peak area counts will be compared to expected values for "background" levels thus ascertaining contaminated soil. Levels of Cu, Zn, Fe, Mn, Pb, As, and Cd will be recorded in the field.

A second refined calibration curve will be developed by linear regression (and multiple linear regression if necessary to factor out matrix effects) with lab sample splits. This site-specific calibration will be used to estimate metal concentrations from XRF data reported in the final deliverable.

Data for all spectral lines will be uploaded onto a lap-top battery-powered microcomputer in the field. A backup hard-copy for Cu, Zn, Fe, Mn, Pb, As, and Cd data will be maintained to guard against inadvertent data loss or equipment malfunction.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
AQUIFER TESTING

PUMPING TESTS

1. Measure water levels in the pumping well and all observation wells daily for several days prior to the test to document water table fluctuation. It is preferable to install a continuous water level recorder to obtain this information.
2. Arrive on-site with all necessary equipment decontaminated and in good repair.
3. Set-up equipment; insure discharge hose/piping is directed away from test area such that the discharge will not influence the test.
4. Choose pump size based on expected well yield reported from previous pumping tests or from the well development logs. It is important to stress the aquifer during the pumping test yet have enough available drawdown for the expected duration of the test.
5. Obtain water level data prior to the test in the pumping well and in all observation wells. Record all data on standardized field forms.
6. Begin trial pumping test by maintaining a constant discharge rate and measuring drawdown in the pumping well with an electric well probe or a pressure transducer. Determine if pumping rate is appropriate for the length of the test. Adjust discharge rate as necessary. Terminate trial test and allow water levels to recover to prepumping elevations.
7. Prepare for constant discharge test by coordinating all personnel involved. Collect water level data every 30 seconds for the first five minutes of the test, every minute for the next five minutes, every two minutes for minutes 10 through 20 of the test, every five minutes for minutes 20 through 40, every 10 minutes for minutes 40 through 60, every 15 minutes for minutes 60 through 100, every 30 minutes for minutes 100 through 1000, and every 60 minutes for the remainder of the test. Following termination of the constant discharge test, collect water level recovery data in a sequence similar to that above with the most frequent measurements obtained early in the recovery tests.
8. During the constant discharge test, obtain measurements of discharge periodically and record on field forms. Adjust discharge as necessary to maintain consistency. Measure field parameters, including pH, SC, and temperature at the time of discharge measurements.



9. Record all data on standard field forms and plot drawdown and recovery curves in the field in accordance with methods described in Lohman (1972) or other appropriate techniques as conditions or aquifer type warrant. Note any irregularities in the test on field forms.
10. Upon completion of aquifer testing, decontaminate all equipment prior to exiting the project area.

Reference:

Lohman, S.W. 1972. Ground Water Hydraulics. U.S. Geological Survey Professional Paper 708. Washington.

SLUG TESTING

1. Arrive on-site with all equipment decontaminated and in good repair.
2. Insert pressure transducer (if applicable) into well to be tested and allow to stabilize. Measure and record static water level prior to initiation of test.
3. Perform test by either withdrawing a known volume of water or inserting a cylinder of known dimensions. Record water level recovery data at frequent intervals on a standardized field form. Measurement frequency should continuously initially, decreasing to every five minutes after approximately 15 minutes into the test. It is preferable to use a continuously recording pressure transducer to record recovery data as data obtained early in the test are typically the most valuable data for slug testing. Record data until recovery is about 95 percent complete.
4. Analyze recorded data in the field in accordance with procedures described in U.S. Department of the Navy (1974), Hvorslev (1951) and/or any other appropriate techniques for the type aquifer being tested.
5. Note any irregularities in test procedures on the field forms.
6. Decontaminate all field equipment prior to leaving each site.

References:

U.S. Department of the Navy. 1974. Naval Facilities Engineering Command

Hvorslev, J.M. 1951. Time lag and soil permeability in ground water observations. Bulletin 36. U.S. Corps of Engineers, Waterways Exp. Sta., Vicksburg, MS.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF REDOX POTENTIAL (Eh)

1. Calibrate instrument in accordance with manufacturer's recommendations daily or more frequently if conditions warrant.
2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.
3. Rinse Eh electrode with deionized water.
4. Fill beaker with sample water; minimize agitation.
5. Immerse electrode in sample and allow several minutes for the probe to equilibrate with the water.
6. Turn on meter. Obtain reading to nearest ten millivolts.
7. Record reading on standardized field forms or in the field book. Note any problems such as erratic readings.
8. Rinse probe with deionized water and store according to manufacturer's directions.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
SURFACE GEOPHYSICAL FIELD METHODS

ELECTROMAGNETICS (EM)

1. Arrive on-site with all necessary equipment in good working order.
2. Establish grid for subsequent profiling by using appropriate flagging and a tape measure. Grid density should be commensurate with detail desired from the profiling survey.
3. Calibrate EM instrument in accordance with manufacturer's direction. Background electrical values should be measured outside known or suspected contaminant areas.
4. Using an EM31-D, or its equivalent, begin profiling transects by continuously monitoring instrument readout. Stop at first flagged station, note and record instrument reading and station number on standardized field forms or in field book. Proceed with the transect repeating the process at other flagged stations. Note any anomalous instrument readings between flagged stations on field forms.
5. At each flagged station, obtain sounding measurement by rotating the coil apparatus 90 degrees. Note and record these values on the field form.
6. If utilities are present at the project site (e.g. power lines, buried linear features), make certain to note the location of these features and any anomalous EM readings resulting from the structures on the field form.

RESISTIVITY SURVEYS

1. Arrive on-site with all necessary equipment to perform a field resistivity survey.
2. Establish resistivity traverse grid as described under EM, above.
3. Choose electrode spacing array in accordance with the project site and commensurate with project objectives. The three commonly used arrays include the Wenner, Schlumberger, and dipole-dipole.
4. Calibrate equipment in accordance with manufacturer's recommendations. As with the EM method, background values should be measured outside known or suspected contaminant areas.
5. Setup equipment at the first flagged site and emplace potential electrodes at desired locations and spacings. Inject current into ground.

6. Obtain readings from voltmeter and record. Calculate and plot apparent resistivities in the field as an immediate quality control check of data collected.
7. Repeat procedure at each station to obtain a resistivity profile of the project area.
8. To perform sounding surveys, vary the spacing of the electrodes at each site. Record data and make field determinations of apparent resistivity values.
9. Note any irregularities encountered both in resistivity values generated and in any utilities present within the study area.





Engineers  
Planners  
Economists  
Scientists

MEMORANDUM

DATE: October 16, 1987  
TO: Mr. Mike Rubich, MDHES  
FROM: Mr. Joe Gerick, CH2M HILL  
SUBJECT: Changes in Pond Bottom Sediment Sampling Techniques

Since the FOP for the Warm Springs Treatment Ponds' Investigations was submitted, the technique that will be used in sampling the bottom sediments in the ponds has been changed. The reason for the change was that a new drilling method was found that would extract an entire soil column and could be used on a small barge. This technique will be used on all pond bottom samples and is described as NETSOP-31 on the attached sheet.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
POND BOTTOM SEDIMENT SAMPLING:

1. Arrive onsite with all necessary equipment in working order. Decontaminate equipment prior to use by using a stiff brush and liquinox solution, rinse with deionized water, rinse with dilute nitric acid, rinse with deionized water. When sampling for organic parameters, insert a hexane rinse prior to the final rinse with deionized water.
2. Set up vibra-core drill system on pontoons while sampling under water or at the site when sampling on land.
3. Drilling will be done using NQ drill steel with clear plastic liners to retain the sample.
4. After the original pond bottom material has been reached, probably gravels and cobbles, the core will be extracted.
5. After the liner has been extracted sampling intervals will be delineated by visual inspection, the sampling tube cut and capped or extruded into sample jars.
6. Decontaminate all equipment prior to leaving sample site.

**NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
POND BOTTOM SEDIMENT SAMPLING**

For purposes of this Field Operations Plan, it is assumed all pond bottom sediment sampling in open bodies of water will be performed during winter months when ice cover is of sufficient thickness to support field personnel and equipment. It is further assumed that for pond bottom sediment sampling of drained or abandoned ponds, where surface water is not present, access for relatively small drill rigs (e.g. auger rigs) is possible.

Ponds Containing Water

1. Arrive onsite with all necessary equipment in working order. Decontaminate equipment prior to use by using a stiff brush and liquinox solution, rinse with deionized water, rinse with dilute nitric acid, rinse with deionized water. When sampling for organic parameters, insert a hexane rinse prior to the final rinse with deionized water.
2. Establish the safety of the ice cover at each sampling site by using an ice bar to determine ice thickness. A minimum ice thickness of six inches is necessary for a safe operating environment.
3. Create access for sampling by chopping an approximately one-foot diameter hole through the ice with an ice bar.
4. Sample flocculated sediments using a Kemmerer-type sampler or its equivalent. Lower Kemmerer to desired depth in a cocked position; send messenger down the hoisting line to trigger closure of the sampling container. Retrieve sample container and transfer sample to appropriate sample container. Enter sample data on appropriate field forms.
5. Sample accumulated sediments and the original pond bottom sediments by inserting a sludge sampling device equipped with a catch basket into the material. Push the sampler into the sediment until refusal is encountered. Extract the sampling device.
6. Retrieve transparent sampling tube from sampling device. Decant any fluid from the top of the sample tube. Visually inspect tube and note depths and thicknesses of the various stratigraphies on field form. Make certain that a sample of the original bottom material is contained in the sample tube. Denote on appropriate forms desired intervals for chemical analyses. Physically mark these same intervals on the sample tube.

If a sample of the original pond bottom material cannot be obtained using the sludge sampling equipment, it may be necessary to use a small lightweight skid-mounted drilling rig to obtain samples at depth. In this instance, advance casing in the borehole created by

the drill rig to maintain the integrity of the borehole in the unconsolidated sediments. Upon reaching the desired sampling depth, equip the drilling rig with a split-spoon sampler to obtain sample. Remove temporary casing.

7. Ready sample tube for shipment to laboratory.
8. Decontaminate all equipment prior to leaving sample site.

#### Ponds Not Containing Water

1. Arrive onsite with all equipment decontaminated and in good working order.
2. Set-up drill rig equipped with a split spoon sampler over desired sample site.
3. Obtain split spoon samples at three foot increments to a depth which intercepts the original pond bottom. Decontaminate split spoon between each sample retrieval. Place samples in plastic sampling bags denoting the interval sampled on the bag.
4. Prepare lithologic descriptions of samples during the collection process. Select approximately five sampled intervals for submittal to the laboratory for chemical analysis. Samples selected should be representative of the variability of material in the accumulated sediment and the underlying original pond bottom and provide for vertical changes in sediment chemistry.
5. Complete necessary paperwork for sample descriptions and sample shipping.
6. Decontaminate all sampling equipment prior to leaving each sample site.

#### Ponds Not Containing Water

1. Arrive onsite with all equipment decontaminated and in good working order.
2. Set-up drill rig equipped with a split spoon sampler over desired sample site.
3. Obtain split spoon samples at three foot increments to a depth which intercepts the original pond bottom. Decontaminate split spoon between each sample retrieval. Place samples in plastic sampling bags denoting the interval sampled on the bag.
4. Prepare lithologic descriptions of samples during the collection process. Select approximately five sampled intervals for submittal to the laboratory for chemical analysis. Samples selected should be representative of the variability of material in the accumulated sediment and the underlying original pond bottom and provide for vertical changes in sediment chemistry.



5. Complete necessary paperwork for sample descriptions and sample shipping.
6. Decontaminate all sampling equipment prior to leaving each sample site.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
PORE WATER SAMPLING

This SOP has been prepared to provide methodologies to obtain samples of pore water in accumulated sediment and in the original pond bottom sediment at ponds containing water. It is assumed pore water sampling will be completed during winter months when adequate ice cover is present to support field personnel and equipment. Collection of pore water in sediments contained in dry or drained ponds should be completed utilizing lysimeters (see NETSOP-32).

1. Decontaminate all equipment in accordance with NETSOP-11.
2. Determine ice thickness at each sampling site. A minimum ice thickness of six inches is necessary for a safe operating environment.
3. Cut an approximately one-foot diameter hole in the ice to provide access for sampling equipment.
4. Drive sandpoint casing with one-foot perforated interval to desired depth. Depths will typically correspond to intervals sampled for analysis of sediment chemistry.
5. Using bailer, evacuate at least three casing volumes of water from the sandpoint. Monitor field parameters for consistency. When field parameters are within plus or minus five percent during three consecutive measurements, sandpoint is ready for sampling.
6. Collect sample. Filter and preserve as appropriate. Complete necessary paperwork.
7. Remove sandpoint. Decontaminate all equipment.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
POND SAMPLING

1. Arrive onsite with all necessary equipment to perform pond water sampling. Decontaminate sampling equipment in accordance with NETSOP-11.
2. Sound depth of water using a weighted measuring device; record data.
3. Lower cocked Kemmerer-type sampler to a depth between six and 24 inches below water surface. This depth should coincide with the interval that contains the most biota in the pond.
4. Send messenger down the sample line to activate the sampler into a closed position. Retrieve sampler.
5. Obtain sample from sampling device by opening sampling port. Analyze field parameters in accordance with NETSOPs 05, 06, 07, 08, and 28. Record all data on standardized field forms.
6. Fill sampling containers and filter and preserve samples as appropriate.
7. Decontaminate sampling equipment in accordance with NETSOP-11.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF TURBIDITY

1. Obtain water sample in accordance with NETSOP-03 or by grab sampling, whichever is appropriate for site conditions.
2. Decontaminate turbidimeter in accordance with NETSOP-11.
3. Calibrate turbidimeter in accordance with manufacturer's recommendations. Be certain to use calibration standards which bracket expected turbidity values.
4. Obtain turbidity measurement from collected sample as soon after sampling as possible.
5. Record data on standardized field forms.
6. Decontaminate turbidimeter in accordance with NETSOP-11.



NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD MEASUREMENT OF SOILS FIELD PARAMETERS

1. Obtain soil sample in accordance with NETSOP-22.
2. Prepare soil paste from soil sample collected by diluting soil with deionized water at a ratio of one volume of soil to three volumes of deionized water in a decontaminated container.
3. Insert probes into the sample paste container and obtain field measurements in accordance with NETSOPs 05, 06, 07, and 28.
4. Decontaminate all field instrumentation and sample containers in accordance with NETSOP-11.
5. Record all collected data on standardized field forms.

NORTHERN ENGINEERING AND TESTING'S  
STANDARD OPERATING PROCEDURE  
FIELD METHOD FOR SAMPLING WATER FOR  
ARSENIC SPECIATION

1. Collect water sample in accordance with NETSOPs 03, 18, or 32.
2. Field filter collected sample in accordance with NETSOP-04.
3. Acidify filtered sample with concentrated hydrochloric acid at a ratio of one milliliter of HCl to 100 milliliters of sample.
4. Place prepared sample into cooler maintained at a temperature of less than 4 degrees C.
5. Complete necessary paperwork.



